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March 1986

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Technical Editors

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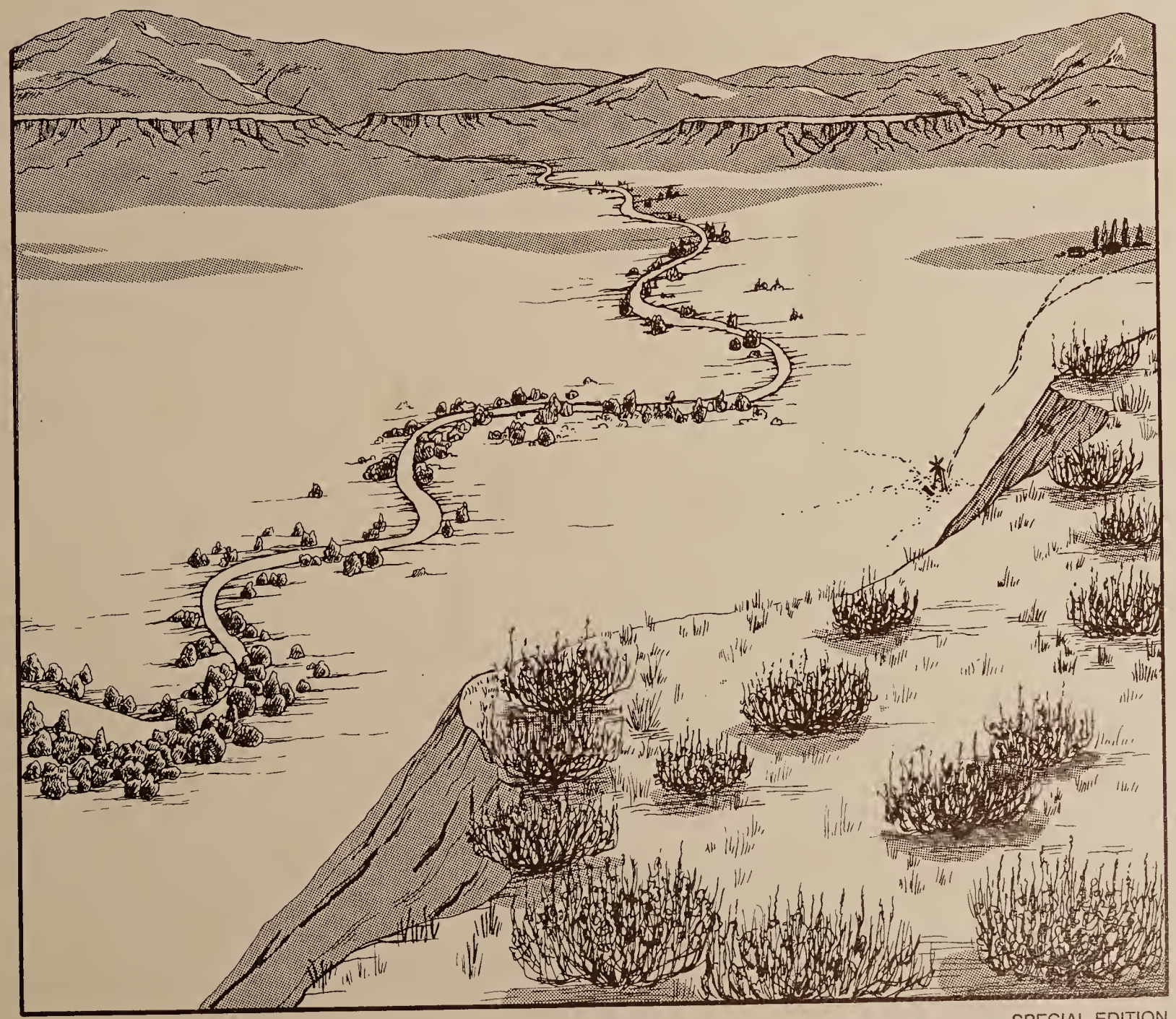

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Introduction

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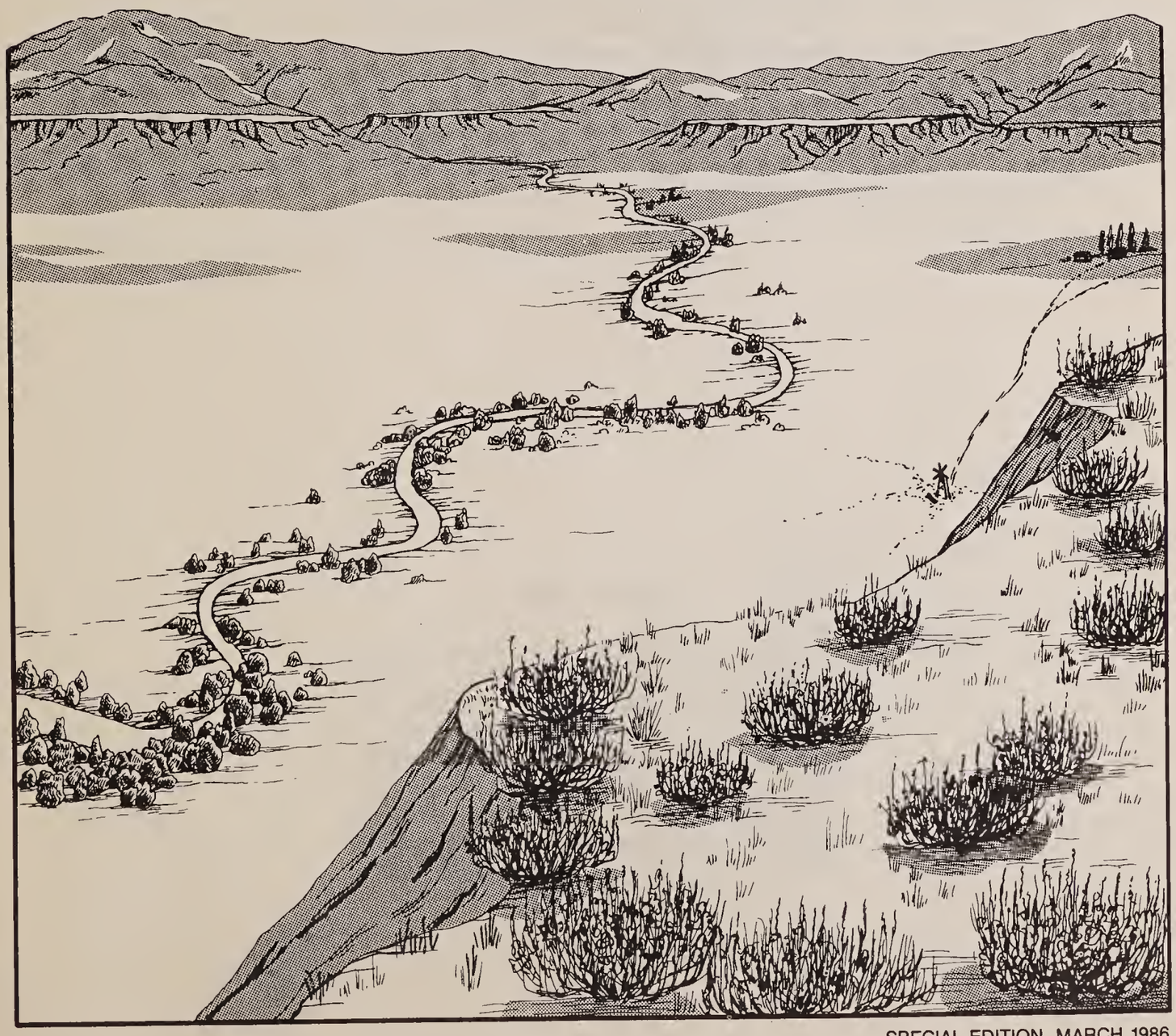
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Introduction

Chris Maser and Jack Ward Thomas



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ABSTRACT

The need for a way by which rangeland managers can account for wildlife in land-use planning, in on-the-ground management actions, and in preparation of environmental impact statements is discussed. Principles of rangeland-wildlife interactions and management are described along with management systems. The Great Basin of southeastern Oregon was selected as a well-defined area for which to develop and display the rangeland-wildlife management principles. This paper introduces the 14-chapter series and outlines each briefly.

THE AUTHORS

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon.** The series on rangelands is adapted from "Wildlife Habitats in Managed Forests—the Blue Mountains of Oregon and Washington" (Thomas 1979), and though parts of the series on rangelands resemble those on the forest, others are completely new. The series provides range managers with information on wildlife and its relationship to habitat conditions in managed rangelands.

The setting for this series of papers is the Great Basin of southeastern Oregon—the Basin and Range and Owyhee Upland Provinces of Franklin and Dyrness (1973) (fig. 1). The information is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands.

The series includes 14 separate publications. Although each part is an independent treatment of a specific subject, when combined in the sequence in which they appear on the inside back cover, the individual parts will be as chapters in a book.

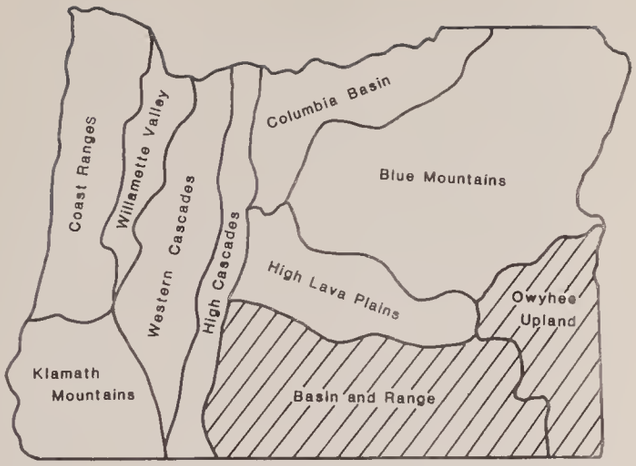

Figure 1.—The physiographic and geological provinces of Oregon (after Franklin and Dyrness 1973). The shaded portion is the area referred to in this report as the "Great Basin of southeastern Oregon."

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, and the U.S. Department of the Interior, Bureau of Land Management, Oregon State Office.

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Introduction

Until a few years ago, a rangeland manager's only concern with wildlife was with "predators" and "big game." The law neither recognized nor required an accountability for wildlife. But times, laws, public demands, and politics have changed. Public rangelands are now considered a prime supplier of livestock and recreation. In fact, they are becoming ever more intensively managed to meet the Nation's burgeoning demands for minerals, water, recreation, grazing, and wildlife. Rangeland managers are under increasing pressure to account for wildlife in management activities, particularly land-use planning. And wildlife means all species—not just species that are hunted, or are esthetically pleasing, or are classified as threatened or endangered. Specific responsibilities for protection and enhancement of wildlife habitats on managed rangelands have been set forth by Federal laws and other legislation. This series of publications is designed to help managers deal more effectively with these new responsibilities.

In turn, the managers are asking more and tougher questions about how range management practices will affect wildlife. The response of wildlife biologists too often varies from "Don't do it" to "We don't know enough to give you an answer." Neither response helps a manager make the necessary evaluations and decisions, and to do nothing is seldom a realistic alternative—economically, politically, or biologically.

Although we probably will never have enough knowledge to make a perfect analysis of the impacts of rangeland management action on wildlife habitat, more information is available than has been used. To be useful, however, it must be organized to make sense biologically and in terms of livestock management.

Past wildlife management in rangelands has been considered from a limited viewpoint in that single species or small numbers of species have been studied and planned for. As a result, wildlife biologists and range specialists have been able to effectively evaluate the impacts of management on only a few species of wildlife.

Perhaps the greatest challenge to professionals engaged in range research and management is to organize knowledge and insights into analytical tools and management strategies that can be readily applied. We began by asking a simple question. What do rangeland managers do that affects wildlife? They manage habitat. Every decision a manager makes that changes the landscape alters wildlife habitat. Habitat is an entity that can be qualified and quantified and for which a manager can be held accountable. And because maintenance of appropriate habitat is the foundation of all wildlife management, it is the key to organizing the knowledge about wildlife so it can be used in managing rangelands. We provide a framework for planning that uses habitat as the key to managing wildlife and thereby makes managers accountable for their actions.

The information presented is a reasonable facsimile of the way managed rangelands and wildlife interrelate. The series may be considered a working hypothesis. It is a place to start—a way to derive responses to questions for which there are no certain answers. As Taylor (1956, p. xi) said: "no . . . book dealing with living creatures is in any sense final. The subject . . . is so fascinatingly complicated that no contribution can be . . . more than a progress report."

Much of the Nation's vast rangelands have changed dramatically in the last 200 years. They can no longer be considered wild because they are now managed to produce multiple benefits, dominated by livestock production but including wildlife. Private lands, of course, are managed to meet the owner's objective—usually production of livestock. Management to enhance livestock production alters wildlife habitat more than any other range management activity.

This series has three purposes: (1) to develop a common understanding of wildlife habitats on managed rangelands; (2) to provide a system for predicting the impacts of range management practices on wildlife; and (3) to show how the system can be applied to a specific area—in this case, the Great Basin in southeastern Oregon.

With the information provided, resource specialists can work together to assure the continued existence of most, if not all, wildlife habitats in managed rangelands.

Livestock management and wildlife habitat management are compatible on public rangelands, but only if the needs of wildlife are recognized and accounted for along with the needs of livestock. Their compatibility can be realized through a better understanding of plant and animal communities, how they change over time, and how they respond to livestock grazing and vegetative manipulation.

By long-standing agreement, the manipulation of nonmigratory wildlife populations or regulation of the harvest of such wildlife on federally managed land is the prerogative of the States. Habitat management on public land is the responsibility of the agencies assigned to manage federally owned lands. Close cooperation is therefore required in setting and achieving wildlife management goals because management of wildlife on public lands is the joint responsibility of both State and Federal governments.

Wildlife as a Product of Rangeland Management

Management of rangelands is the process of controlling the environment to produce a mix of desired products. That mix changes with time, economic conditions, and capability of the land. Congress, through laws, determines what these products, including wildlife, on public lands shall be (fig. 2). The "granddaddy" law of public rangelands was the 1934 Taylor Grazing Act, which directed the Secretary of the Interior to preserve wildlife (Bean 1977). A number of laws (fig. 2) specify or intimate that wildlife shall be a product of Federal lands and that wildlife shall be considered in every management decision. Other regulations result from agency and court interpretations of these laws. Managers of State lands and private landowners are influenced by applicable State laws.

Wildlife habitat, on most managed rangelands, has been a byproduct of management to enhance production of livestock. As demands have grown for the products of rangelands, it has become obvious that such clichés as "good range management is good wildlife management" will no longer suffice. Passage of the National Environmental Policy Act of 1969 (U.S. Laws, Statutes, etc.; Public Law 91-190) required that the environmental effects and trade-offs of any federally financed project must be fully evaluated.

The Need

How is a public rangeland manager to balance demands for rangelands, including wildlife, and still maintain a sustained yield of livestock forage? How can managers account for the needs of all wildlife? In seeking answers to these questions, the wisdom of two of Commoner's (1971) "laws" of ecology becomes apparent—"everything is connected to everything else," and "there is no such thing as a free lunch." Any action that alters vegetation has an influence on wildlife habitat and, in turn, on wildlife. If wildlife is of concern, goals for wildlife must be established and all management actions must be judged against those goals. Rangeland managers must not be solely livestock managers. They must take a more holistic view.

The Federal Land Policy and Management Act of 1976 (U.S. Laws, Statutes, etc.; Public Law 90-2743) requires that detailed and holistic plans be prepared for the management of public rangelands. Further, the National Environmental Policy Act of 1969 (U.S. Laws, Statutes, etc.; Public Law 91-190) requires that the environmental impacts and consequences of planned actions involving Federal funds be examined and revealed. One of the weakest aspects of such planning has been the inability of managers to predict the effects of management alternatives on wildlife populations. This has frequently resulted in criticism of land-use plans and environmental impact statements by the public, other agencies, and the courts.

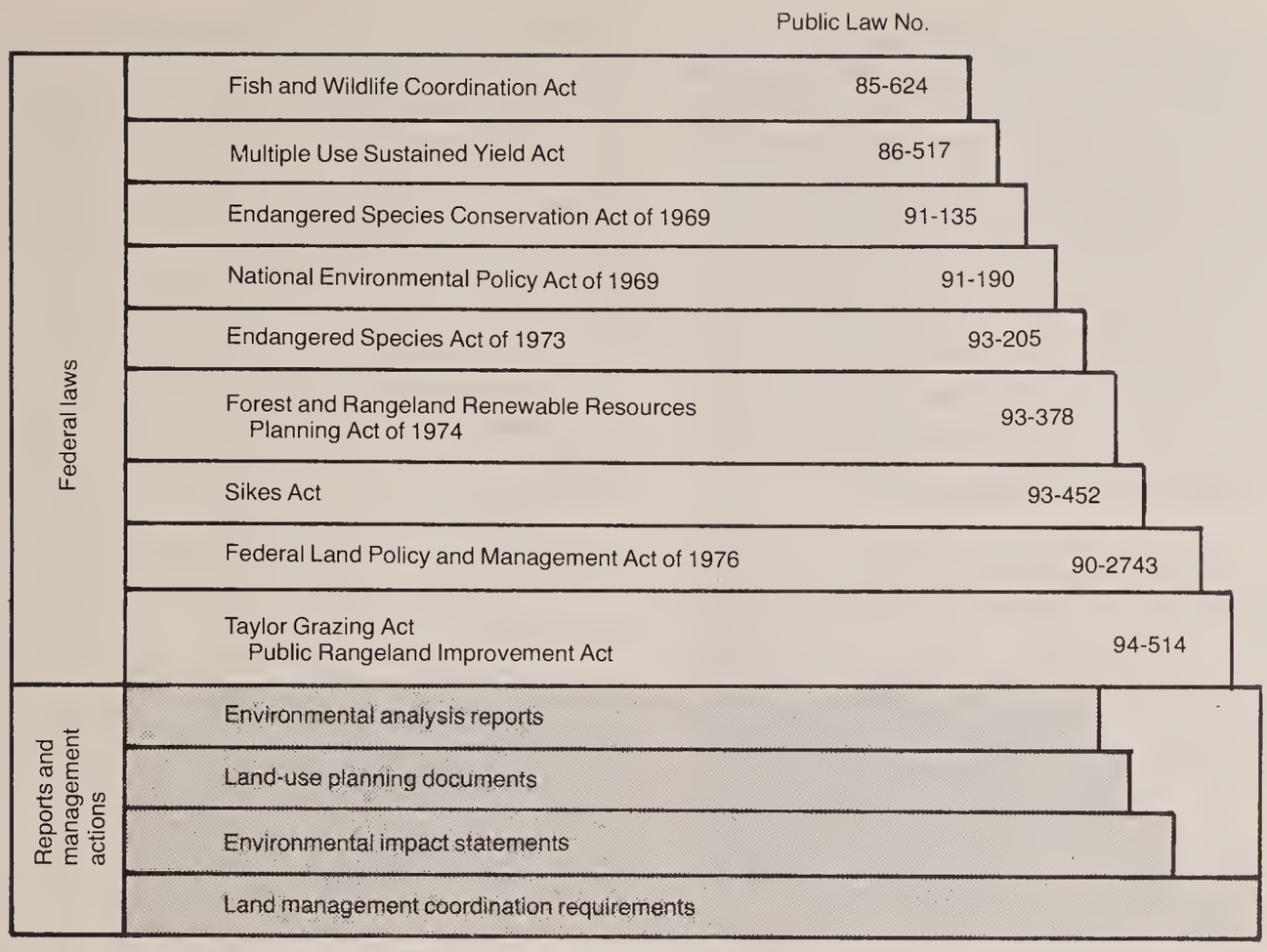

Figure 2.—Some major Federal laws and planning requirements that influence wildlife habitat management on public lands (adapted from Thomas 1979).

General criticism of rangeland management and land-use planning by conservationists and wildlife biologists does little to help wildlife. What will help are better techniques to predict the consequences of management on wildlife, whether good or bad. Managers need a conceptual framework that will enable them to: (1) account for habitat needs of all vertebrate wildlife, (2) emphasize management of particular wildlife species, and (3) identify habitats that require special attention. The greatest challenge is to integrate existing information so it can be readily used in resource planning. Giles (1962, p. 404-405) described the problem as follows:

> Certainly, research is needed, but while waiting, we need to work with what we have. Work to be done is not for the research staff, but the management team who sees the needs, recognizes limitations, and can make modifications to fit existing conditions. The "applied ecologist" needs to start applying.

Development of a process to consider the impacts of management on wildlife is needed. Land-use planning continues at full speed; large-scale conversions of sagebrush-dominated rangelands to crested wheatgrass and other species are being contemplated and implemented; and the demand for increased forage production (that is, increased livestock grazing) from public lands is incessant. Some say it is too soon to undertake such a task, that there is too little "hard" data. But there are really only two choices—too soon or too late. The first is preferable. With intensified management of rangelands, impacts on wildlife are magnified. We need to get on with the job.

Managers need more flexibility in applying technical information to local situations. The information is presented as a system to predict the consequences of management alternatives on wildlife, rather than as specific guidelines. Thus, a manager has the ability to respond to particular situations while being fully accountable for the impacts of such decisions on wildlife habitat. Managers can survey alternatives, make trade-offs, and account for those decisions.

A Basic Assumption

A basic assumption about wildlife habitat in rangelands managed for multiple use is that management must be carried out in coordination with livestock management. On public rangelands in the Great Basin of southeastern Oregon, as in many other parts of North America, livestock production is the dominant land use. Large-scale alterations of wildlife habitat usually result from the manipulation of vegetation primarily to enhance livestock production. Management for livestock production, therefore, is de facto wildlife management. The degree to which it is good wildlife management depends on how well habitat is manipulated to achieve wildlife goals. These interrelationships are shown in figure 3.

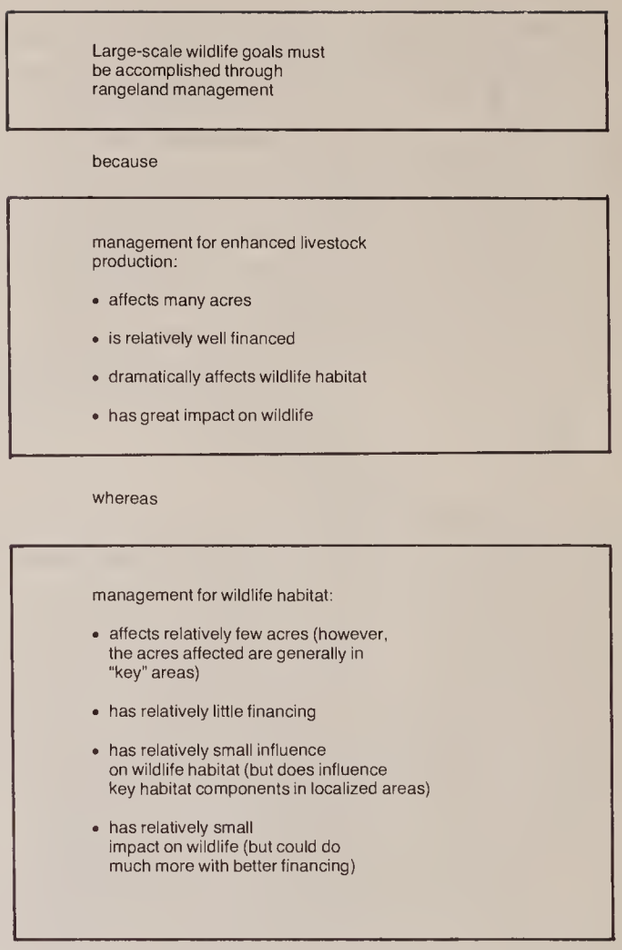

Figure 3.—Large-scale management of wildlife habitat must be mainly accomplished through rangeland management (adapted from Thomas 1979).

Wildlife habitat management may require control of vegetation, but this is usually too expensive solely for wildlife purposes. There are exceptions, however, such as the establishment of special watering sources and protection of particular habitats from livestock grazing. Management practices undertaken to enhance livestock production can cause dramatic changes in wildlife habitat; these practices, when correctly planned and executed, can be a practical way to achieve wildlife habitat goals.

A wildlife biologist is normally responsible for making the manager aware of the ramifications of proposed management activities on wildlife habitats. A manager normally considers advice from many staff specialists and selects a course of action. But it is the field range specialist who actually manipulates the vegetation and alters habitat. It is therefore essential that range managers, range specialists, and wildlife biologists work closely together.

To paraphrase Giles (1962, p. 406), it is time to concede that the production of livestock has more intense, widespread influence on wildlife than any technique applied by a wildlife biologist to enhance habitat. In one large-scale manipulation of vegetation to enhance forage production for livestock, a rangeland manager can influence more habitat over a longer time than a wildlife manager, acting alone with current levels of funding, can create in a decade. Wildlife biologists, to be really effective, must simultaneously realize the potential of these rangeland manipulations to enhance forage for livestock and must increase their effectiveness in obtaining modifications in these practices to make them the least damaging, or even to enhance wildlife habitat.

Principles of Rangeland-Wildlife Management

Resource management professionals come from varied backgrounds: range management, ecology, geology, wildlife biology, fisheries biology, engineering, animal husbandry, and landscape architecture, to name a few. To work together, they need a common vocabulary and understanding of range management principles, plant and animal ecology, and wildlife management. The relationship between terms used in range and wildlife habitat management is shown in figure 4. Touched on by Odum (1963), Leopold (1933), and Hylander (1966), these definitions are mainly from Thomas (1979).

Habitat is the place where an animal finds the required arrangement of food, cover, and water to meet its biological needs. Each species is adapted to a **habitat niche** or specific arrangement and amount of food, cover, and water. The role a particular wildlife species plays in the environment is referred to as its **ecological niche.**

A **plant community type** is a unique combination of plants that occurs in particular locations under certain environmental influences. The plant community type reflects the environmental influences of the site, such as soil, temperature, elevation, solar radiation, slope, aspect, and rainfall as they influence vegetation (Daubenmire 1976).

Plant communities, as described in chapter 2 (Dealy et al. 1981), are defined in terms of dominant overstory and understory species of climax vegetation. Several plant community types may be included. A plant community evolves through a general series of conditions as it progresses from bare ground to **climax** stage. This process is called **succession**, and the various stages are known as **successional stages.** But in rangeland communities in which the vegetation is manipulated, singly or in combination, by fire, mechanical means, herbicides, and ungulate grazing, succession is commonly so radically modified that when a relatively stable state is maintained by people or their domestic animals it can be called a stage of **disclimax** (= disturbance climax) or **anthrogenic subclimax** (= human generated) (Odum 1971). In this series, these disclimax states are referred to as **structural conditions.**

Each combination of a plant community and a successional stage or structural condition produces a unique set of habitat niches. The wildlife supported by these habitat niches make up the attendant **animal community.** The animals fill various ecological niches and, in turn, influence the plant community. Individual species may use a particular habitat on a seasonal or a yearlong basis. See also reviews of Meslow and Wight (1975) and Thomas et al. (1975).

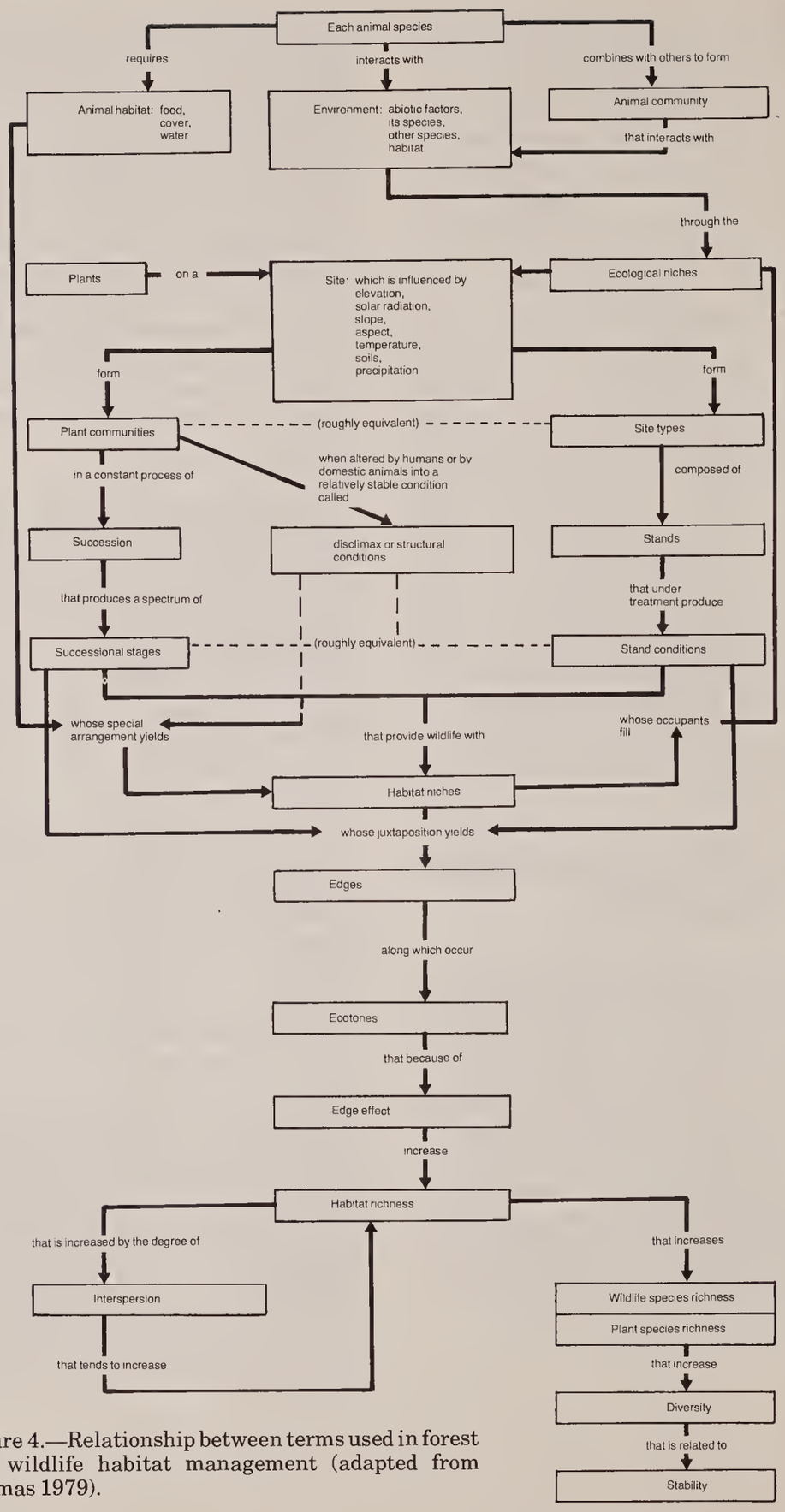

Figure 4.—Relationship between terms used in forest and wildlife habitat management (adapted from Thomas 1979).

Some of the terms already discussed have counterparts that are used primarily in range management. It is important to understand their relationship to the language of ecology and wildlife biology.

A **site** is an area considered in terms of its environment, particularly as this determines the type and quality of the vegetation the area can support. Sites are qualitatively classified into **site types** by their climate, soil, and vegetation. Site type is roughly analogous to the plant community.

Each site is occupied by one or more **stands.** A **stand** is a plant community that has sufficient uniformity of composition, size, density, age, spatial arrangement, and condition to distinguish it from adjacent communities. Stands are the common basis on which prescriptions to manipulate vegetation are considered. The **stand condition** can be described by measuring these factors. Manipulation of vegetation alters stand condition. When wildlife habitat is considered, stand condition is roughly analogous to successional stage or structural condition because both reflect the composition and structure of the stand.

The juxtaposition of plant communities, successional stages, or stand conditions within communities produces **edge.** The area where communities or successional stages overlap or produce a distinct combination of plants or structure is called the **ecotone.** Edges and their ecotones are rich habitat for wildlife because they have attributes of the edge itself plus those of the adjoining communities or successional stages (Leopold 1933). The influence of this phenomenon on animal populations is called **edge effect.**

Increasing the amount of edge increases **habitat richness,** which is a measure of the number of wildlife species resident within an area. **Interspersion** is a measure of the degree to which plant communities or successional stages mix. An increase in interspersion increases the amount of edge. In turn, this may increase **diversity** or the variety that exists in plant and animal communities (Patton 1975). Increased diversity in plant communities provides an increasing number of habitat niches that, in turn, support more animal species. A rangeland with a high degree of diversity of communities and successional stages provides habitat for a wide variety of wildlife (Odum 1971).

Increased diversity is thought to be related to community **stability.** Stability is the ability of a community to withstand catastrophe (Margalef 1969) or to return it to its original state after severe alteration. Diversity is assumed to provide flexibility to managers by insuring resilience to recover from disturbance to the "system." Such a cause and effect is suspected but has not been proved. Odum (1971, p. 256) stated:

> If it can be shown that biotic diversity does indeed enhance physical stability in the ecosystem, or is the result of it, then we would have an important guide for conservation practice. . . . is variety only the spice of life or is it a necessity for the long life of the total ecosystem comprising man and nature?

A **rangeland ecosystem** is a dynamic complex of plant and animal communities, along with the abiotic environment that comprises one functioning whole. Any change in vegetative structure or composition will favor some wildlife species while adversely affecting others. Such changes can affect the number and type of wildlife species and their use of habitat.

Rangeland-Wildlife Management Systems

Wildlife management is the scientifically based art of skillfully controlling habitat to enhance conditions for a selected species or of manipulating animal populations to achieve other desired ends (fig. 5). The term "wildlife management" implies the ability and managerial flexibility to control habitat factors or animal populations, or both (Giles 1971, Leopold 1933, Trippensee 1948).

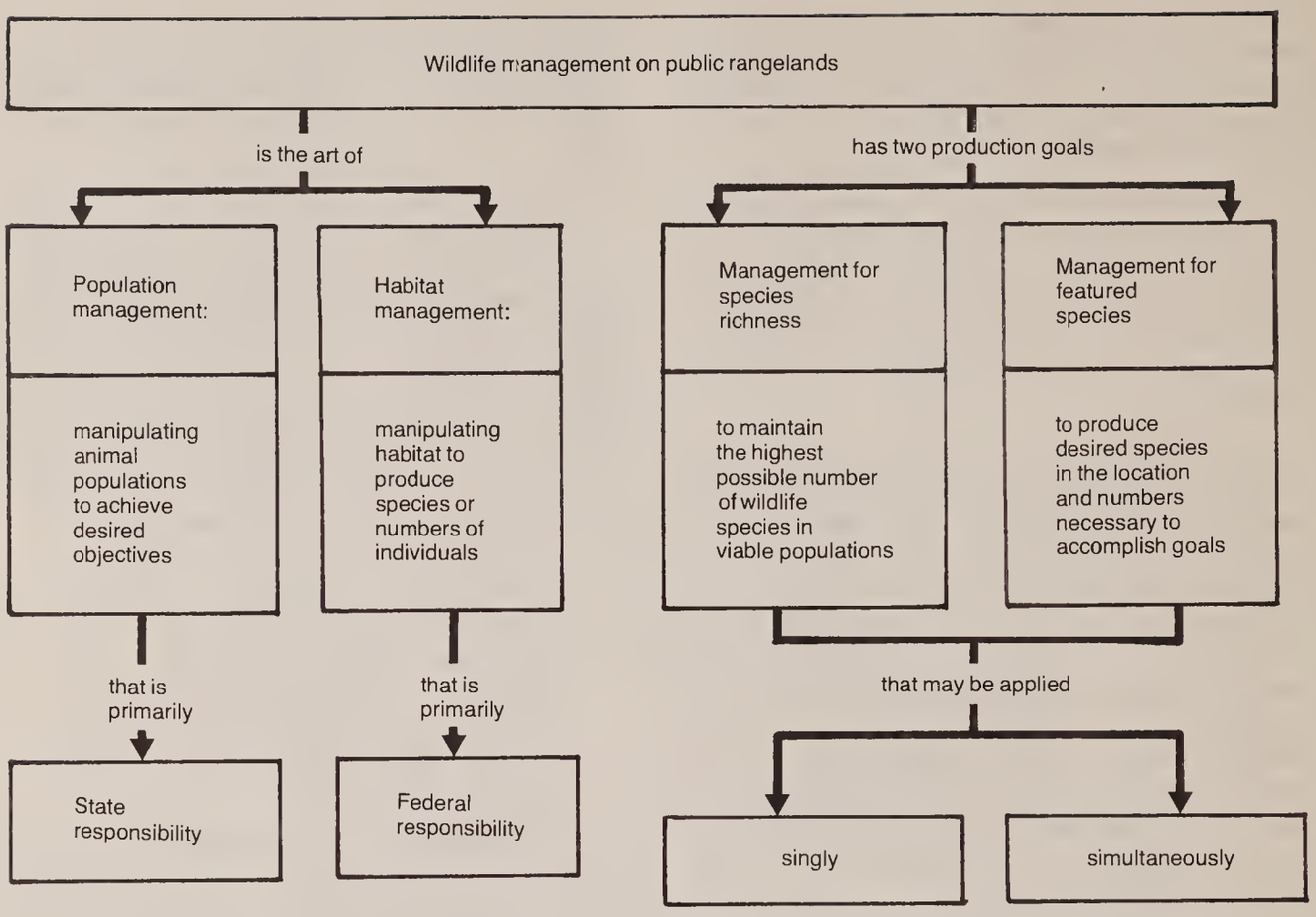

Figure 5.—The art and goals of wildlife management on public rangelands (adapted from Thomas 1979).

There are two general production goals in wildlife management—management for species richness (Evans 1974; Siderits 1975; USDA Forest Service 1973, 1975) and management for featured species (Holbrook 1974, USDA Forest Service 1971, Zeedyk and Hazel 1974) (fig. 6).

The goal of management for species richness is to insure that most resident wildlife species are maintained in viable numbers in the managed area (King 1966). Hence, all species are important. Management for species richness can be achieved by providing a broad spectrum of habitat conditions; characteristic stages or structural conditions of adequate size of each plant community should be represented in the vegetative mosaic. It is therefore necessary to have information on the habitat needs of each species. This must then be incorporated into guides to protect the integrity, stability, and diversity of the rangeland ecosystem. The result should be a relatively stable and varied wildlife population.

Under management for featured species, the goal is to produce selected species in desired numbers in specific locations. This can be achieved by manipulating vegetation so the limiting factors of food, cover, and water are made less limiting for the desired species. These may be game species, threatened or endangered species, or species that have particular esthetic value.

Production goal	Management for species richness	Management for featured species
Objective	Insure that all resident species exist in viable numbers. All species are important.	Produce selected species in desired numbers in designated locations. Production of selected species is of prime importance.
Process	Manipulate vegetation so that characteristic stages of each plant community are represented in the vegetative mosaic.	Manipulate habitat factors so that limiting factors are made less limiting.

Figure 6.—Production goals in wildlife management (adapted from Thomas 1979).

Management for featured species has also been called "key-species management" or "indicator-species management" if the species selected represents the habitat needs of several species. If the species to be featured are carefully selected and their habitat needs vary widely, then management for featured species will also insure habitat diversity. The result can be similar to management for species richness.

The two management systems can also be simultaneously used to insure species richness while favoring selected species in specific locations for particular purposes. For example, management for species richness can be accomplished by providing an approximate mix of successional stages or stand conditions (structural conditions) within each plant community. Management for featured species can be accomplished by arranging stand size and successional stages to provide both cover and forage for selected species.

Rangelands are managed—that is, the vegetational composition and structure are controlled—through one or a combination of the following: (1) shrubs are controlled by mechanical means, herbicides, or fire; (2) controlled areas are frequently seeded with grasses, forbs, and shrubs palatable and nutritious for livestock; and (3) grazing management, defined as ". . . manipulation of livestock grazing to accomplish a desired result" (Kothmann 1974, p. 36), is employed. Grazing management may include deferred grazing or use of a grazing system that is defined as "a specialization of grazing management which defines systematically recurring period of grazing and deferment for two or more pastures or management units" (Kothmann 1974, p. 36). Kothmann (1974) said there are many possible combinations of the four primary factors involved in any grazing system (number of pastures, number of herds, length of grazing periods, length of rest periods); but other factors, such as season of use, species of livestock, and class of livestock, must also be taken into account. In addition, such management involves livestock density and distribution of grazing within pastures or management units, which can be influenced by fencing, location of drinking water, or herding.

There are many options available to achieve the desired compositional and structural state of vegetation under the constraints of what the site can support, the availability of resources, and limitations of law, regulation, or custom. That the goals and objectives be clearly set and the progress toward those goals be periodically evaluated is of overriding importance. The goals and objectives must encompass both livestock production and wildlife habitat. It is essential that these goals and objectives be developed in conjunction with and cooperation between user groups and resource specialists and be stated in terms of vegetative condition first and numbers of outputs, such as animal unit months (AUM) of grazing or animal units (AU), second.

The Setting

The Great Basin of southeastern Oregon falls mainly into the Owyhee Upland physiographic province and partly in the Basin and Range physiographic province (Franklin and Dyrness 1973) (fig. 1). It includes portions of Malheur and Harney Counties. The landscape is mostly rolling plateau at 1 066 meters (3,500 ft) in elevation, but there are mountains, cliffs, and canyons. Annual precipitation ranges from 18 to 30 centimeters (7 to 12 inches) (Heady and Bartolome 1977).

The Great Basin rangelands in southeastern Oregon support 28 plant communities dominated by grasses, shrubs, or trees. Trees vary from conifers to deciduous and evergreen hardwoods. Big sagebrush[1] communities predominate, whereas tree-dominated and true grassland communities constitute the least common types. True grasslands occur as relict meadows, relict stands of valley bottom bunchgrass, and relict subalpine bunchgrass types (Dealy et al. 1981, Maser and Strickler 1978).

[1] Scientific names are listed in the appendix.

Tree-dominated communities occur primarily at elevations above the sagebrush steppe, with the exception of low-elevation riparian willow and cottonwood communities. Quaking aspen is restricted primarily to mountain riparian zones associated with streams, seeps, springs, ponds, lakes, or snowdrift sites. With the exception of relict ponderosa pine and white fir, curlleaf mountainmahogany requires the most moisture of the dry-land tree types in the high desert mountains. Western juniper grows immediately below the curlleaf mountainmahogany and intermixes with it in transition zones. These tree-dominated communities are adjacent to and above the shrub zones (Dealy et al. 1981).

Big sagebrush, including several subspecies, dominates the shrub communities. Other significant tall shrub communities include black greasewood, squaw apple, Bolander silver sagebrush, and mountain silver sagebrush. Short shrub communities include shadscale saltbush, stiff sagebrush, low sagebrush, early low sagebrush, black sagebrush, and cleftleaf sagebrush (Dealy et al. 1981).

The diversity of topography and plant communities made the Great Basin of southeastern Oregon an ideal place to develop and test the range-wildlife management systems discussed in this series of papers.

The land ownership in the Great Basin of southeastern Oregon is shown in table 1. The Bureau of Land Management (BLM) controls the majority of the land (66 percent); 29 percent is in private ownership.

Agriculture and grazing of domestic livestock are the activities that dominate management of private land. Grazing of domestic livestock is the dominant use on BLM-administered lands. In 1980, 373 permittees ran 116,806 head of cattle and horses and 5,945 sheep composing 618,608 AUM on BLM lands (U.S. Department of the Interior, Bureau of Land Management 1981).

Table 1—Land ownership in the Great Basin of southeastern Oregon

Ownership	Hectares	Acres	Percent
Bureau of Land Management	3 025 792	7,476,881	66
Other Federal	62 506	154,456	1
State	174 944	432,296	4
Private	1 302 875	3,219,467	29
Total	4 566 117	11,283,100	100

Livestock management was facilitated on BLM lands in the Vale and Burns Districts from 1934 through 1981 by the following actions: Vegetation was manipulated on 140 770 hectares (347,702 acres); crested wheatgrass was seeded on 211 682 hectares (522,856 acres); 7 192 kilometers (4,469 mi) of fence was constructed; 477 cattle guards were installed; 1 611 kilometers (1,001 mi) of road was constructed to move livestock; 1 286 kilometers (799 mi) of water pipe was laid; 927 water storage tanks were built; 2,119 reservoirs were constructed; 749 springs were developed; and 121 wells were drilled (U.S. Department of the Interior, Bureau of Land Management 1981).

Extensive public ownership increases pressure from local governments for more intensive livestock management that, in turn, increases employment.

Livestock grazing has been relatively constant since the 1870's (Maser and Strickler 1978). The livestock industry of the area is strongly dependent on public rangelands, and it seems likely that there will be increasing pressure on the public rangelands of southeastern Oregon to provide red meat to sustain the local economy.

At the same time, these rangelands are being increasingly used for recreation. The number of people hunting and fishing has continued to grow. This results in more pressure to produce and sustain large numbers of game animals. The number of "rock hounds" has also increased. Such special use allocation will heighten pressure from industry and the public on managers of public rangelands to produce more red meat on fewer hectares (acres) at less cost to the livestock industry.

Increasing demands for more red meat, wildlife, fish, recreation, wilderness, and water from a finite land area inevitably lead to conflicts. Careful, farsighted management is necessary to obtain the desired wildlife and wildlife-related recreational experiences from such heavily managed rangelands.

The Following "Chapters"

The following 13 "chapters" in this series are presented in a sequence designed to logically develop certain principles and ideas. Chapter 2 ("Plant Communities and Their Importance to Wildlife") describes the major plant communities and examines the importance of their structure and species composition to wildlife. It establishes the basis for discussion of vegetation and habitats that occur in all the chapters in this series.

Chapters 3 and 4, "The Relationship of Terrestrial Vertebrates to Plant Communities and Structural Conditions," relate all terrestrial vertebrate species known to occur within the area to habitats associated by the plant communities described in chapter 2 and to subdivisions described by common structural conditions within those plant communities. The hypothesis is that each species is adapted to a particular habitat, and the likelihood of occurrence can be predicted by the quantity and quality of that habitat. The purpose is to allow the manager to deal simultaneously with all species in land-use planning or in preparing environmental analyses.

Chapters 5 through 10 were prepared in recognition that some species receive more attention than others in land-use planning and management. Or, as Orwell (1946, p. 112) put it: "All animals are equal but some animals are more equal than others." Federal agencies, for example, are required by law to pay particular attention to species designated as threatened or endangered. More attention is also paid to economically important species, such as game species, species trapped for furs, or species considered particularly interesting or esthetically pleasing. The chapters on native trout, sage grouse, pronghorns, mule deer, and bighorn sheep are examples of how more extensive information can be provided for featured species.

Chapters 11 through 14 discuss special and unique habitats. Special habitats are biological in nature and can be at least partially controlled by the rangeland manager; they play a critical role in the lives of many species. These habitats include riparian zones and edges. Unique habitats are geomorphic in nature, usually cannot be easily manipulated to the advantage of wildlife, and are critical to certain species. These habitats are geomorphic and edaphic habitats and manmade habitats.

The chapter on management practices and options demonstrates how a manager can use management options to meet diverse wildlife goals and, at the same time, provide grazing for livestock. The message is that both wildlife and livestock management objectives can be met if the two are simultaneously derived and flexibility and careful planning are inherent in the process.

Together, these 14 chapters are an example of what can be done to provide the rangeland manager with the information necessary to fully consider wildlife in land-use planning, in preparing environmental impact statements, and in enhancing or protecting wildlife habitats.

Acknowledgment

Ira D. ("Dave") Luman, former biologist with the Bureau of Land Management dedicated his career to enhancement or protection of wildlife habitats in the managed rangelands and forests of Oregon. He was the moving force behind the development of this series and worked diligently to insure the resources needed to develop, publish, and distribute this series.

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Appendix

COMMON AND SCIENTIFIC NAMES

Common name	Scientific name
MAMMALS[1]	
Bighorn sheep	*Ovis canadensis*
Cattle	*Bos taurus*
Domestic sheep	*Ovis aries*
Horse	*Equus caballus*
Mule deer	*Odocoileus hemionus*
Pronghorn	*Antilocapra americana*
BIRDS[2]	
Ferruginous hawk	*Buteo regalis*
Sage grouse	*Centrocercus urophasianus*
SHRUBS[3]	
Big sagebrush	*Artemisia tridentata*
Black greasewood	*Sarcobatus vermiculatus*
Black sagebrush	*Artemisia nova*
Bolander silver sagebrush	*Artemisia cana* subsp. *bolanderi*
Cleftleaf sagebrush	*Artemisia arbuscula* subsp. *thermopola*
Early low sagebrush	*Artemisia longiloba*
Low sagebrush	*Artemisia arbuscula* subsp. *arbuscula*
Mountain silver sagebrush	*Artemisia cana* subsp. *viscidula*
Sagebrush	*Artemisia* sp.
Shadscale saltbush	*Atriplex confertifolia*
Squaw apple	*Peraphyllum ramosissimum*
Stiff sagebrush	*Artemisia rigida*
TREES[3]	
Cottonwood	*Populus* sp.
Curlleaf mountainmahogany	*Cercocarpus ledifolius*
Ponderosa pine	*Pinus ponderosa*
Quaking aspen	*Populus tremuloides*
Western juniper	*Juniperus occidentalis*
White fir	*Abies concolor*
Willow	*Salix* sp.
GRASS AND GRASSLIKE PLANTS[3]	
Crested wheatgrass	*Agropyron cristatum* or *Agropyron desertorum*

[1] After Walker et al. (1975).
[2] After American Ornithologists' Union (1957).
[3] After Garrison et al. (1976).

Plant Communities

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United States
Department of
Agriculture

Forest Service

United States
Department of
the Interior

Bureau of
Land Management

General Technical
Report PNW-120

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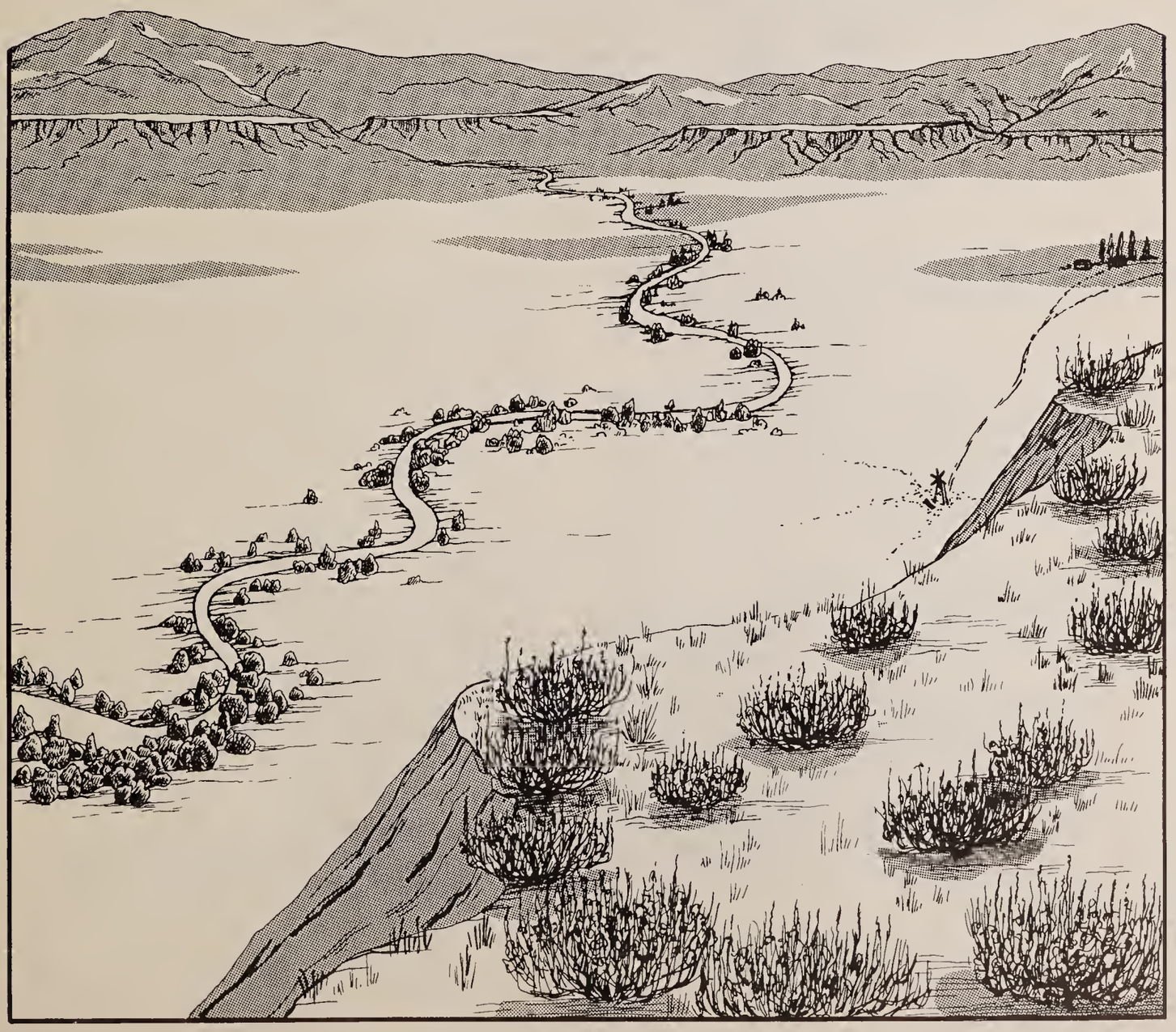
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Plant Communities and Their Importance to Wildlife

J. Edward Dealy, Donavin A. Leckenby, and Diane M. Concannon



SPECIAL EDITION, MARCH 1986

ABSTRACT

Plant communities in the Great Basin of southeastern Oregon are described, and a field key is provided. The value of a plant community's vertical and horizontal structure and the seasonal availability of its forage are examined in relation to wildlife habitat in managed rangelands. Further, the importance of individual and combined plant communities to wildlife in managed rangelands is discussed, and management alternatives are presented.
KEYWORDS: Communities (plant), range management, wildlife habitat.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon**. The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Our purpose is to describe the major plant communities and examine the importance of their structure and species composition to wildlife. Plant communities here are directly related to the wildlife covered in the other chapters and can be used in developing management plans based on characteristics and potential of the plant community. We did not cover some northern Great Basin rangeland communities because they are rare, small in total area, or information is not available.

Great Basin rangelands in southeastern Oregon support a wide variety of plant communities, dominated by grasses, shrubs, or trees ranging from conifers to deciduous and evergreen hardwoods. Predominant are big sagebrush communities.[1] Tree-dominated and true grassland communities constitute the least common types. True grasslands occur as meadows, relict stands of valley bottom bunchgrass, and subalpine bunchgrass types.

Tree-dominated communities occur primarily at elevations above the sagebrush steppe, except willow and cottonwood communities of low-elevation riparian zones. Quaking aspen is primarily restricted to mountain riparian zones, such as streams, seeps, springs, ponds, or lakes (fig. 1). With the exception of relict stands of ponderosa pine (Packard 1972) or white fir (Hansen 1956), curlleaf mountainmahogany requires the most moisture of the dry-land tree types in the high desert mountains. Western juniper grows just below curlleaf mountainmahogany and mixes with it in transition zones. These tree-dominated communities are adjacent to and above the shrub zone.

Big sagebrush, including several subspecies, is dominant among the shrub communities. Other significant tall shrub communities include black greasewood, squaw apple, Bolander silver sagebrush, and mountain silver sagebrush. Short shrub communities include shadscale saltbush, and stiff, low, early low, black, and cleftleaf sagebrushes.

[1]Common and scientific names and plant symbols are from Garrison et al. (1976) and are listed in the appendix.

The terms "stand" and "community" are used as suggested by international agreements on terminology (Küchler 1964, Mueller-Dombois and Ellenberg 1974). The specific unit of vegetation observed in the field is called a vegetation stand or stand (coenosis). The generalized, abstract unit of vegetation analogous to an "average" of a group of similar stands is a plant community or vegetation type. A plant community with a "definite flora, uniform habitat, and physiognomy" is called an association (Mueller-Dombois and Ellenberg 1974, p. 174).

Plant communities presented here are compared with Küchler's (1964) vegetation types in table 1. Küchler has one major vegetation type for each listing, which represents the major physiognomy (general aspect and visual character) of a region. Küchler omits other similar vegetation types less extensive in occurrence and less noticeable or refers to them as inclusions because his treatment of vegetation throughout the conterminous United States is so extensive. Table 1 shows single vegetation types of Küchler's related to a number of vegetation types used in this publication. The best example is Küchler's (1964) "sagebrush steppe"—the big sagebrush-bearded bluebunch wheatgrass vegetation type. We recognize 11 vegetation types dominated by sagebrush within Küchler's (1964) "sagebrush steppe." The Wyoming big sagebrush/bunchgrass vegetation type described here is probably the only one relating directly to it since it is considered the most common sagebrush of the high desert in Oregon (Winward 1980).

Subtle variations in an environment give rise to different subordinate plant species in communities. These "characteristic" and "differentiating" species (Mueller-Dombois and Ellenberg 1974) are useful indicators of site potential. For example, the mountain big sagebrush/bunchgrass community encompasses stands containing either Thurber needlegrass, western needlegrass, or needle-andthread. These grasses are generally subordinate to bearded bluebunch wheatgrass and reflect an increasing sandiness of the soil profile. Recognition of these three variations

Figure 1.—Elevation and site relationships among dominant plant species in the Great Basin of southeastern Oregon. Plant symbols are from Garrison et al. (1976). AGSP = *Agropyron spicatum*; ARAR = *Artemisia arbuscula*; ARCA = *Artemisia cana*; ARLO2 = *Artemisia longiloba*; ARNO2 = *Artemisia nova*; ARRI = *Artemisia rigida*; ARSP = *Artemisia spinescens*; ARTR2 = *Artemisia tripartita*; ARTRT = *Artemisia tridentata* subsp. *tridentata*; ARTRV = *Artemisia tridentata* subsp. *vaseyana*; ARTRW = *Artemisia tridentata* subsp. *wyomingensis*; ATCO = *Atriplex confertifolia*; CARU = *Calamagrostis rubescens*; CELE = *Cercocarpus ledifolius*; CEVE = *Ceanothus velutinus*; DISTI = *Distichlis* sp.; ELCI = *Elymus cinereus*; FEID = *Festuca idahoensis*; GRSP = *Grayia spinosa*; JUOC = *Juniperus occidentalis*; MURI = *Muhlenbergia richardsonis*; PIPO = *Pinus ponderosa*; POSA3 = *Poa sandbergii*; POTR = *Populus tremuloides*; PREM = *Prunus emarginata*; SAVE2 = *Sarcobatus vermiculatus*; SIHY = *Sitanion hystrix*; SYOR = *Symphoricarpus oreophilus*.

Table 1—Comparison of the plant communities with potential natural vegetation by Küchler (1964)

Natural vegetation as described by Küchler (1964)	Plant communities in this publication
37 mountainmahogany-oak scrub (similar position—not equal)	Curlleaf mountainmahogany/mountain big sagebrush/bunchgrass Curlleaf mountainmahogany/mountain snowberry/grass Curlleaf mountainmahogany/pinegrass Curlleaf mountainmahogany/Idaho fescue Curlleaf mountainmahogany/bearded bluebunch wheatgrass-Idaho fescue
No provision	Squaw apple/bunchgrass
55 sagebrush steppe (with juniper)	Western juniper/big sagebrush/bearded bluebunch wheatgrass Western juniper/big sagebrush/Idaho fescue
55 sagebrush steppe	Basin big sagebrush/bunchgrass Wyoming big sagebrush/bunchgrass Mountain big sagebrush/bunchgrass Threetip sagebrush/bunchgrass Bolander silver sagebrush/bunchgrass Mountain silver sagebrush/bunchgrass Stiff sagebrush/bunchgrass Low sagebrush/bunchgrass Cleftleaf sagebrush/bunchgrass Early low sagebrush/bunchgrass Black sagebrush/bunchgrass
40 saltbush-greasewood	Black greasewood/grass Shadscale saltbush/bunchgrass
No provision	Riparian
No provision	Permanently wet meadows Seasonally wet meadows
No provision	Quaking aspen/mountain big sagebrush Quaking aspen/grass
No provision	Subalpine big sagebrush/bunchgrass
52 alpine meadows and barren (similar—not equal)	Subalpine bunchgrass

within the community should help managers of wildlife and livestock. The associated changes in soil texture[2] and plant phenology are important to programs designed to maintain suitable habitat for animals and to increase production of forage.

[2]Soil nomenclature and definitions are from "Soil Survey Manual" (Soil Survey Staff 1951).

PLANT AND COMMUNITY STRUCTURE

Most animal species are more narrowly adapted to plant structure for thermal and hiding cover than they are to plant species for food. For example, mule deer and black-tailed jackrabbits use a wide variety of forage species (Hill 1956, Ingles 1967, Kufeld et al. 1973); but a specific structure of trees or shrubs (fig. 2) is required to fulfill their thermal or hiding cover requirements (Anthony 1928, Thomas et al. 1979a). The sage sparrow has seed and insect food available in many plant communities, but a specific shrub structure is required to provide hiding cover and suitable nesting sites (Gabrielson and Jewett 1940, Miller 1968). The overhanging or umbrellalike structure of bunchgrass provides both hiding and thermal cover for birds, such as the lark sparrow in the open bunchgrass communities (fig. 3).

Figure 2.—Big sagebrush provides important thermal cover for small mammals (Robert R. Kindschy photograph).

Figure 3.—A, arrow at the base of a bunchgrass points to the nest of a lark sparrow. B, the nest is hidden from predators and is protected from sun and wind in an open stand of grass by the overhanging blades of grass (Chris Maser photograph).

Shrub structure is variously altered from browsing by different animals and at different intensities (fig. 4). Antelope bitterbrush, for instance, when severely browsed produces a crown that appears to be structurally different, depending on type and intensity of use (Hormay 1943). This species also occurs throughout its range in different structural forms because of what appear to be genetically distinct populations (Alderfer 1976, Nord 1965).

B

Figure 4.—A, lightly used antelope bitterbrush illustrating the open form. B, antelope bitterbrush heavily browsed by deer illustrates the dense, hedged form. C, antelope bitterbrush heavily browsed by cattle develops a low, dense, mushroom-shaped crown that hampers nesting of some bird species within the crown but provides good thermal and hiding cover for a variety of vertebrate species.

The structural diversity of rangeland communities relates directly to wildlife diversity: the greater the structural diversity, the greater the wildlife diversity (fig. 5). Exceptions may occur where a mosaic of diverse stands is on a scale too small to meet the home range needs of a species that requires large blocks of uniform vegetation (Thomas et al. 1978, 1979c).

Figure 5.—Cliffs, talus, sagebrush, juniper, seasonally and permanently wet meadows, and riparian vegetation provide habitat for a wide variety of wildlife in the western edge of the Great Basin.

Plant communities contain both vertical and horizontal structural elements. At least three vertical vegetative layers—herbaceous, shrub, and tree (fig. 6)—are provided by western juniper communities in high desert rangelands. MacArthur and MacArthur (1961) considered vertical layers of vegetation critical to diversity of avian species. Thomas et al. (1977) examined each 5-foot layer of vegetation from shrubs to the tops of trees and found that

Figure 6.—This tree-shrub-grass community illustrates the structural variety present and the high vertical diversity in some communities of the high desert. Plant symbols are from Garrison et al. (1976). AGSP = *Agropyron spicatum*; ARABI = *Arabis* sp.; ARTRV = *Artemisia tridentata* subsp. *vaseyana*; ASTRA = *Astragalus* sp; CHNA = *Chrysothamnus nauseosus*; FEID = *Festuca idahoensis*; JUOC = *Juniperus occidentalis*; SIHY = *Sitanion hystrix*; STIPA = *Stipa* sp.

different species of birds were significantly correlated with different vertical layers in both coniferous and deciduous vegetation. Horizontal diversity, on the other hand, deals primarily with stands of different plant communities or different stages within plant communities that are close together (fig. 7). For example, optimum spacing between stands of big sagebrush and crested wheatgrass for black-tailed jackrabbits requires that the wheatgrass openings be no larger than 600 meters (1,900 ft) across (Westoby and Wagner 1973), because most use of wheatgrass occurs within 300 meters (985 ft) of the type edge. This illustrates how the size of two adjacent communities can result in optimum habitat for a particular animal species.

Rangelands of the desert basins, uplands, and mountains are limited in their complement and acreage of tree communities and true (climax) grasslands. The abundant shrub communities are predominantly big sagebrush. In the enhancement of both livestock range and wildlife habitat, a mixture of communities in proper juxtaposition and of optimum stand size provides a more suitable environment than large uniform areas of seeded grasslands or dense shrublands. Tree communities, such as western juniper and curlleaf mountain-mahogany, provide valuable thermal and hiding cover for wild ungulates (deer, pronghorn, bighorn sheep) and other species of wildlife, as well as important shading areas for livestock in the summer.

These communities with an open tree cover, besides being good wildlife habitat, produce an ideal opportunity for livestock to obtain much needed shade close to forage. McIlvain and Shoop (1971) studied the use of shade by cattle in the southern Great Plains and found that summer-long gains by yearling Hereford steers increased 9 kilograms (19 lb) per head when shade was available. They also found that shade was nearly as effective as the location of water and supplemental feed in distributing use by cattle. Advantages of shade for livestock, then, are threefold: increased weight gain, increased forage supply, and more uniform range conditions. These advantages also apply to ungulate wildlife.

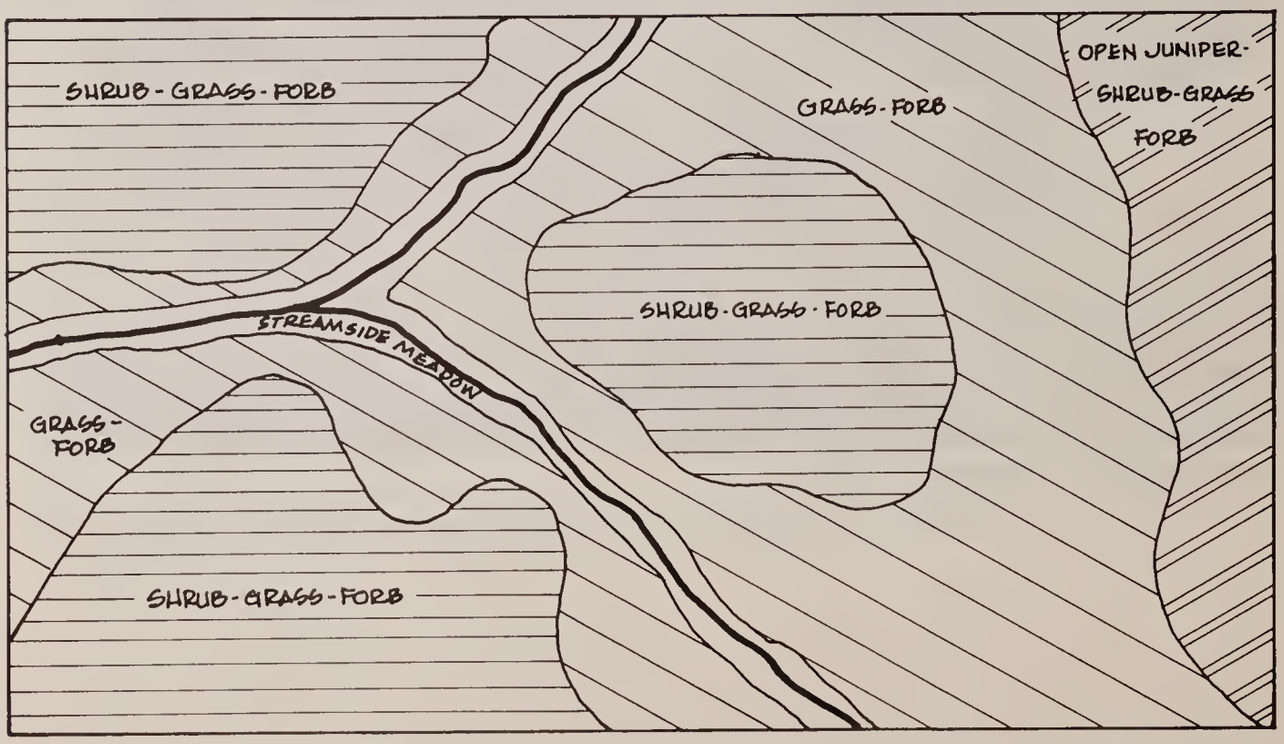

Figure 7.—A variety of habitats produces a variety of wildlife. A mosaic of plant communities of appropriate sizes and shapes maximizes edge and provides a wide selection of forage and cover species.

AVAILABILITY OF FORAGE

Forage availability of high desert plant communities varies annually and seasonally (fig. 8). Annual herbaceous species are available as green forage in early spring but dry rapidly and provide only dry material by late spring. Most perennial herbaceous species are generally available from midspring to midsummer, whereas deciduous shrub and tree species usually provide their most nutritious forage from midspring through late summer. Evergreen and deciduous shrub and tree forage is available throughout the year, although nutritional value peaks in the early growing season. Annual and perennial herbaceous species produce nutritious regrowth after fall rains. Although production varies among years, regrowth is usually available throughout the winter, particularly on south-facing exposures.

Controlled seasonal use is the key to coordinated use of the same range by livestock and wild ungulates. Controlled livestock use of perennial grasses can produce a stubble height of some plants short enough to allow wild ungulates to reach green regrowth that otherwise would be unavailable to them. Also, important winter foraging areas of wild ungulates can be enhanced by preventing livestock from grazing after fall rains have produced herbaceous regrowth.

PLANT COMMUNITY GROUPS

The array of plant communities listed in the following key and later described in detail can be dealt with individually in management. Depending on the user's objective, however, simplified groupings of these communities may be made (table 2). A criterion for grouping might be that the combined communities have equivalent values for livestock or for a featured wildlife species; or the communities in the group would react in an equivalent way to a specific management program (Leckenby 1978a). The rationale for grouping plant communities and examples of the relationships of terrestrial vertebrates to such groups will be presented in another chapter in this series, "The Relationship of Terrestrial Vertebrates to the Plant Communities."

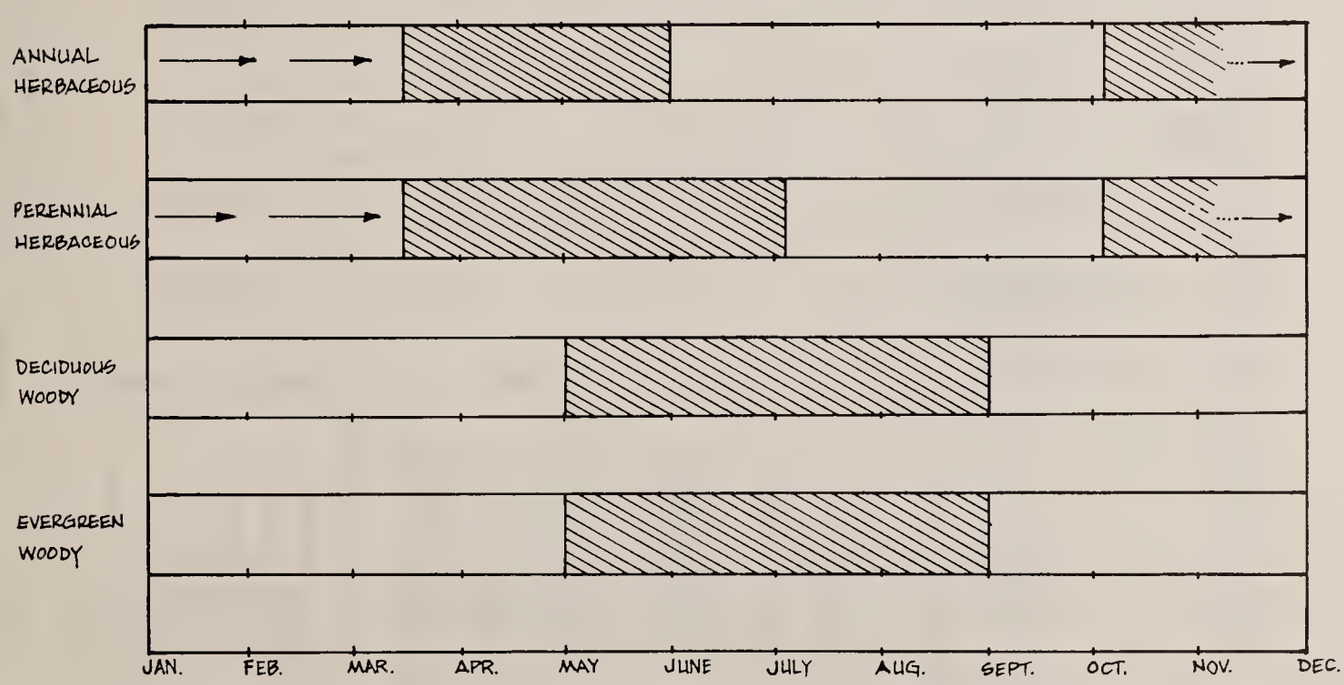

Figure 8.—Completely shaded blocks indicate the season of greatest productivity and nutritional value for forage plants. Partially shaded blocks with arrows indicate nutritious fall regrowth.

Table 2—Plant communities grouped by similarity of structure and selected structural and site characteristics[1]

Community number	Page number	Community	Structurally similar	Maximum number of vertical layers	Maximum height; meters (feet)	Ungulate thermal cover	Ungulate hiding cover	Ungulate forage	Small vertebrate thermal cover	Small vertebrate hiding cover	Small vertebrate forage	Elevational range; meters (feet)	General soil depth[2] and other notes
1	17	Riparian		4	25.0 (80)	X	X	X	X	X	X	All	Highly variable in soil depth and stoniness
2	17	Quaking aspen/grass		4	21.0 (70)	X	X	X	X	X	X	1 525- (5,000- 2 134 7,000)	Moderately deep to deep
3	18	Quaking aspen/mountain big sagebrush		4	12.0 (40)	X	X	X	X	X	X	1 525- (5,000- 2 134 7,000)	Moderately deep to deep
4	20	Curlleaf mountainmahogany/ mountain big sagebrush		3	7.0 (23)	X	X	X	X	X	X	1 600- (5,250- 1 950 6,400)	Shallow to moderately deep; stoniness variable
5	22	Curlleaf mountainmahogany/ mountain snowberry											
6	22	Curlleaf mountainmahogany/ Idaho fescue		2	7.0 (23)	X	X	X	X	X	X	1 600- (5,250- 1 700 5,575)	Moderately deep; stoniness variable
7	22	Curlleaf mountainmahogany/ bearded bluebunch wheatgrass/ Idaho fescue											
8	24	Curlleaf mountainmahogany/ pinegrass										1 750- (5,750- 1 920 6,300)	Moderately shallow; stoniness highly variable
9	25	Western juniper/big sagebrush/ bearded bluebunch wheatgrass		4	10.0 (33)	X	X	X	X	X	X	777- (2,550- 1 450 4,750)	Shallow to moderately deep; stoniness variable
10	25	Western juniper/big sagebrush/ Idaho fescue											
11	31	Basin big sagebrush/bunchgrass		3	2.4 (8)	X	X	X	X	X	X	Below 2 140 (7,000)	Moderately deep to deep; stoniness variable. Silver sagebrush flooded in spring
12	35	Mountain big sagebrush/ bunchgrass										1 070- (3,500- 2 900 9,500)	
13	35	Subalpine big sagebrush/ bunchgrass										1 070- (3,500- 2 900 9,500)	
14	37	Wyoming big sagebrush/ bunchgrass										Below 1 980 (6,500)	
15	38	Threetipped sagebrush/ bunchgrass										915- (3,000- 1 830 6,000)	
16	40	Bolander silver sagebrush/ bunchgrass										1 680- (5,500- 2 440 8,000)	
17	40	Mountain silver sagebrush/ bunchgrass										1 680- (5,500- 2 440 8,000)	

Table 2—Plant communities grouped by similarity of structure and selected structural and site characteristics[1] (Continued)

Community number	Page number	Community	Structurally similar	Maximum number of vertical layers	Maximum height; meters (feet)	Ungulate thermal cover	Ungulate hiding cover	Ungulate forage	Small vertebrate thermal cover	Small vertebrate hiding cover	Small vertebrate forage	Elevational range; meters (feet)	General soil depth[2] and other notes
18	42	Stiff sagebrush/bunchgrass		2	.4 (1.3)	—	—	X	X	X	X	915-2 134 (3,000-7,000)	Very shallow and mostly very stony over a layer restricting root growth; saturated in spring
19	44	Low sagebrush/bunchgrass										915-2 745 (3,000-9,000)	
20	44	Cleftleaf sagebrush/bunchgrass										1 525-2 745 (5,000-9,000)	
21	47	Black sagebrush/bunchgrass										1 220-2 745 (4,000-9,000)	
22	47	Early low sagebrush/bunchgrass										1 830-2 440 (6,000-8,000)	
23	48	Squaw apple/bunchgrass		3	1.5 (5)	X	X	X	X	X	X	760-1 525 (2,500-5,000)	Moderately deep to deep
24	49	Black greasewood/bunchgrass		2	1.5 (5)	X	X	X	X	X	X	600-1 525 (2,000-5,000)	Deep; flooded in spring
25	51	Shadscale saltbush/bunchgrass		2	.5 (1.6)	—	—	X	X	X	X	760-1 525 (2,500-5,000)	Moderately deep; no apparent layer restricting root growth
26	52	Meadow, seasonally wet		1		—	—	X	X	X	X	All	Deep; saturated to flooded in spring. dry in summer and fall
27	54	Meadow, permanently wet		1		—	—	X	X	X	X	All	Deep; saturated to flooded in spring; perennially wet
28	55	Subalpine bunchgrass		1	.3 (1.2)	—	—	X	X	X	X	2 439-2 900 (8,000-9,500)	Shallow to deep; stoniness variable

[1]X=present
[2]Very shallow—less than 25 centimeters (10 inches); shallow—26 to 50 centimeters (10 to 20 inches); moderately deep—51 to 125 centimeters (20-49 inches); and deep—more than 126 centimeters (49 inches).

Key to Plant Communities

CONSTRUCTION OF KEY

The plant communities are identified in a dichotomous key by descriptive vegetation and site characteristics easily recognized in the field. Groups of communities are separated on broad characteristics, such as trees vs. no trees, broadleaf trees vs. coniferous trees, shrubs vs. no shrubs, and so forth. Here we consider curlleaf mountainmahogany a tree. Site information, such as elevation or topography, is used as an aid in distinguishing communities or groups of communities. Separation within community groups may be based on vegetative differences among dominant species, such as anatomical variations in leaves alone or in combination with differences in form or height.

Some native communities are not covered. Some stands will not key to a community because of their early stage of succession. In stands where community identification is difficult, users should refer to the section, "successional vegetation."

KEY

The general riparian zone will be identified here rather than within the structure of the key because there is insufficient information from which to develop a multiple community key section: It is a zone with communities immediately adjacent to water, that require large amounts of free or unbound water, that may be dominated by trees, shrubs, or grasses, and that may be multilayered — (RIPARIAN ZONE COMMUNITIES, page 17).

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1a Communities with tree cover (tree communities not in key; see "SUCCESSIONAL VEGETATION" page 55)

2a Cover dominated by broadleaf trees

3a Tree cover dominated by quaking aspen

4a Shrub cover of mountain big sagebrush common to abundant (QUAKING ASPEN/MOUNTAIN BIG SAGEBRUSH) 18

4b Shrub cover sparse to absent (QUAKING ASPEN/GRASS) 17

3b Tree cover dominated by curlleaf mountainmahogany

5a Shrub cover common

6a Shrubs primarily mountain big sagebrush (CURLLEAF MOUNTAINMAHOGANY/MOUNTAIN BIG SAGEBRUSH/BUNCHGRASS) 20

6b Shrubs primarily mountain snowberry (CURLLEAF MOUNTAINMAHOGANY/MOUNTAIN SNOWBERRY/GRASS) 22

5b Shrub cover sparse to absent

7a Understory primarily bunchgrass

8a Grass layer obviously dominated by Idaho fescue (CURLLEAF MOUNTAINMAHOGANY/IDAHO FESCUE) 22

8b Grass layer not obviously dominated by Idaho fescue; grass a codominant mixture of bearded bluebunch wheatgrass and Idaho fescue (CURLLEAF MOUNTAINMAHOGANY/BEARDED BLUEBUNCH WHEATGRASS-IDAHO FESCUE) . . . 22

7b Understory not primarily bunchgrass; grass predominantly pinegrass (CURLLEAF MOUNTAINMAHOGANY/PINEGRASS) . . . 24

2b Cover dominated by coniferous trees; dominant tree western juniper with a shrub layer dominated by big sagebrush

9a Grass cover dominantly bearded bluebunch wheatgrass (WESTERN JUNIPER/BIG SAGEBRUSH/BEARDED BLUEBUNCH WHEATGRASS) 25

9b Grass cover dominantly Idaho fescue (WESTERN JUNIPER/BIG SAGEBRUSH/IDAHO FESCUE) 25

1b Communities without tree cover

10a Communities with shrub cover dominant; grasses and forbs mostly native (shrub communities not in key; see "SUCCESSIONAL VEGETATION" page 55)

11a Dominant mature[3] shrubs taller than 5 decimeters (20 inches)

12a Dominant shrub a sagebrush species[4]

13a Dominant shrub with persistent (overwintering), entire (leaf edges smooth), and lance-shaped leaves

14a Leaves of dominant shrub silver-gray, plants in internally drained basins with seasonal flooding; associated herbaceous vegetation usually sparse; soil alkaline and extremely clayey (BOLANDER SILVER SAGEBRUSH/BUNCHGRASS) . . . 40

[3]Mature sagebrush considered at least 20 years old by count of annual rings or xylem layers of main stem (Winward 1980). This should also be the guide for other shrub species.

[4]Sagebrush and attendant site characteristics from Winward (1980) and Winward and Tisdale (1977).

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14b Leaves of dominant shrub green-gray, plants along margins of streams or meadows; associated herbaceous vegetation floristically rich and highly productive; variable soils (MOUNTAIN SILVER SAGEBRUSH/BUNCHGRASS). . . . 40

13b Dominant shrubs with persistent lobed and wedge-shaped leaves

15a Dominant shrub uneven topped, with flowering shoots (inflorescences) arising throughout the crown (bottom to top); branches appear as upright feathery sprays

16a Mature shrubs greater than 100 centimeters (40 inches) tall; leaf margins straight, forming a tapered wedge; common big sagebrush community of valley bottoms and foothills on deep, well-drained soils (BASIN BIG SAGEBRUSH/BUNCHGRASS) 31

16b Mature shrubs less than 100 centimeters (40 inches) tall; leaf margins flare outward, forming a bell-shaped wedge; sagebrush on dry sites commonly below 1 830 meters (6,000 ft) and on moderately deep, well-drained soils (WYOMING BIG SAGEBRUSH/BUNCHGRASS) 37

15b Dominant shrubs even topped with flowering shoots (inflorescences) arising from the upper portion of the crown and extending above the foliage

17a Dominant shrub with leaf margins belled outward; flower stalks absent, flowers attached directly to main stem of flowering shoot (inflorescence spicate) or flower stalks present but unbranched (inflorescence racemose); widespread through the high desert steppe (LOW SAGEBRUSH/BUNCHGRASS) 44

17b Dominant shrub with leaf margins not belled outward, leaf margins straight; flower stalks branched (inflorescence paniculate)

18a On dominant shrub, four to six individual (very small) flowers per head; found on deep, well-drained soils throughout the upper foothill and mountain areas where soil moisture is available most of the summer (MOUNTAIN BIG SAGEBRUSH/ BUNCHGRASS) 35

18b On dominant shrub, more than six individual (very small) flowers per head; often roots from branches in contact with soil (layering); found at high elevations (most commonly above 2 000 meters or 6,500 ft) (SUBALPINE BIG SAGEBRUSH/ BUNCHGRASS) 35
(Treated briefly under mountain big sagebrush/ bunchgrass community description)

12b Dominant shrub not a sagebrush species

19a Dominant shrub spiney, bark is whitish; usually found on alkaline soil where water table is shallow—flood plains, playas, and terraces (BLACK GREASEWOOD/GRASS). 49

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19b Dominant shrub not spiney, bark is dark; usually occurs on high moist hillsides in the northern edge of the high desert steppe; often near the ponderosa pine zone and often mixed with antelope bitterbrush (SQUAW APPLE/BUNCHGRASS) 48

11b Dominant mature shrubs shorter than 5 decimeters (20 inches)

20a Dominant shrub with leaf edges smooth (leaves entire), spines present on branches; occurs primarily on alkaline soils in desert plains and foothills (SHADSCALE SALTBUSH/BUNCHGRASS) 51

20b Dominant shrub with leaves divided or lobed, lacking spines

21a Leaves of dominant shrub divided into lobes; lobe length more than three times lobe width

22a Dominant shrub with flowering shoot leaves divided; flower stalks absent, flowers attached directly to main stem of flowering shoot (inflorescence spicate); all leaves winter deciduous; most commonly found in the north and west edge of the Great Basin and beyond, in Oregon, on shallow rocky soils (STIFF SAGEBRUSH/BUNCHGRASS) 42

22b Dominant shrub with flowering shoot leaf edges smooth (entire)

23a Flower stalks branched (inflorescence paniculate); leaves on upper flowering shoots much longer than flower heads; found in the northern part of the Great Basin in Oregon and north; grows on moderate to deep, well-drained, loamy and sandy loam soils (THREE-TIP SAGEBRUSH/BUNCHGRASS) 38

23b Flowering shoots with flower stalks (pedicels) unbranched (racemose) or absent (spicate); flowering shoot leaves equal to or only slightly longer than flower head; most common to the north of the Great Basin in Oregon, occurring only at moderately high elevations of 1 500 to 2 700 meters (5,000 to 9,000 ft), and usually within the conifer zone (CLEFTLEAF SAGEBRUSH/BUNCHGRASS) 44
(Cleftleaf sagebrush treated briefly under low sagebrush/bunchgrass)

21b Leaves of dominant shrub divided into lobes; lobe length less than three times lobe width

24a Flowering shoots (inflorescences) of dominant shrub with flower stalks (pedicels) branched (paniculate); fruits mature after August; seed stalks brownish and persistent into following year; leaves very small; stands of plants appear dark in color compared with low sagebrush; occurs on droughty, stony, and often calcareous soils (BLACK SAGEBRUSH/BUNCHGRASS) 47

24b Flower shoots (inflorescences) of dominant shrub with flower stalks unbranched (racemose) or absent (spicate); seed stalks grayish and weakly persistent into following year

25a Fruits of dominant shrub mature in July or early August (EARLY LOW SAGEBRUSH/BUNCHGRASS) 47

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25b Fruits of dominant shrub mature from late August to October; widespread throughout the Great Basin of southeastern Oregon
(LOW SAGEBRUSH/BUNCHGRASS) 44

10b Communities without shrub cover, shrub cover sparse, or shrub cover sparse with introduced grass species (grass or forb communities not in key; see "SUCCESSIONAL VEGETATION," page 55)

26a Communities reseeded with introduced grasses and with or without introduced forbs, or communities appearing as bunchgrass types below 2 440 meters (8,000 ft) with or without a sparse shrub cover; mostly sagebrush communities with the shrub component eliminated or reduced by fire, chemicals, or mechanical means

27a Rehabilitated with introduced species; old seedings may have big sagebrush or rabbitbrush, and native grasses and forbs mixed at various densities with crested wheatgrass; seedings sometimes include introduced forbs
(CRESTED WHEATGRASS SEEDINGS—not discussed in text)

27b Rehabilitated without introduced species (shrub cover removed by fire, chemical, or mechanical means); residual native species used for natural reseeding of grass stand; often dominated by bearded bluebunch wheatgrass, with a mix of other species present
(SUCCESSIONAL VEGETATION) 55

26b Communities not reseeded

28a Sod-forming grasslands

29a Occurring in permanently wet situations along streams, ponds, or lake
(PERMANENTLY WET MEADOWS) 54

29b Occurring in places that are seasonally wet a significant part of the year; near streams or near other moist areas
(SEASONALLY WET MEADOWS) 52

28b Not sod-forming grasslands; bunchgrass communities in the subalpine zone above 2 440 meters (8,000 ft)
(SUBALPINE BUNCHGRASS) 55

Riparian Zone Communities

Riparian zones are identified by the presence of vegetation that requires free or unbound water or conditions that are more moist than normal (Thomas et al. 1979b). Riparian plant communities within this zone are complex and highly variable in structure, number of species, species composition, productivity, and size. This variability is due, in part, to the interaction of water quality, hydraulics, hydroperiod, topography, soil, geology, elevation, animal use, and alterations by people (Odum 1971, 1979; Thomas et al. 1979b). They are disproportionately important among Great Basin plant communities, yet there is probably less known about them than any other major zone under management.

Because of the complexity of the riparian zone and a lack of information on riparian vegetation in the Great Basin of southeastern Oregon, this section is limited to a general discussion. The riparian zone in relation to management is discussed by Thomas et al. (1979b).

1—RIPARIAN

Riparian communities vary structurally from a low grass and grasslike layer to a tree layer reaching above 25 meters (80 ft) and include many combinations of grasses, forbs, shrubs, and trees in between. Density of vegetation varies markedly. Because most woody vegetation is deciduous, however, hiding and thermal cover is effective primarily during the growing season.

Concentrated and valuable forage resources characterize this community. Intensive grazing may alter vegetation, causing not only a loss of forage but a different community structure and reduced productivity for the site. Soil losses through erosion of streambanks and lowering of water tables through channelization may permanently reduce plant productivity or change the vegetation. For example, a streambed lowered by erosion can cause a lower water table in the adjacent meadow and convert the meadow to a shrub community.

Management decisions must be made on a case by case basis because of the high variability between communities in the zone. Many critical site factors that influence productivity change from one riparian community to another.

Quaking Aspen Communities

Quaking aspen communities are scattered through mountainous areas of the Great Basin, most commonly at elevations from 1 550 to 2 150 meters (5,000 to 7,000 ft). These communities are usually found on wet sites but occasionally occur in combination with mountain big sagebrush.

2—QUAKING ASPEN/GRASS (fig. 9)

Vegetation

Crown cover of quaking aspen in the quaking aspen/grass community varies from 25 to 75 percent. Some stands have a two-tiered tree canopy—a mature and a reproduction layer. Mature stands reach a mean height of 21 meters (70 ft) with a mean stem diameter

Figure 9.—Quaking aspen/grass community along an intermittent streambed. Note the lack of reproduction and close cropping of grass and forbs by livestock and mule deer.

(breast high) of 36 centimeters (14 inches) and a maximum diameter of 56 centimeters (22 inches). Basal area (area of tree trunks covering the ground surface) of one large mature stand was 28 square meters per hectare (120 ft^2 per acre).[5] When present, the shrub layer is sparse and consists of occasional plants of mountain big sagebrush, green rabbitbrush, or mountain snowberry averaging 40 centimeters (16 inches) in height.

Grass and forb species, plant composition, and plant density vary among stands, partially because of varying amounts of moisture and severity of livestock use. Common grasses include blue wildrye, wheatgrass, needlegrass, hairgrass, or bottlebrush squirreltail[6] (see footnote 5). Total crown cover of the grass-forb layer may vary from less than 5 to over 30 percent. Height of the grass layer averages about 40 centimeters (16 inches).

Stinging nettle, a forb, often dominates disturbed stands. Other common forbs include peavine, aster, dandelion, sorrel, cinquefoil, and bedstraw (see footnotes 5 and 6). False hellebore and thistle are occasionally found. Dominant forb species average 1 meter (3.28 ft) tall. Some stands, however, lack tall forbs, such as stinging nettle, sorrel, false hellebore, and thistle. Height of forbs in such stands averages 30 centimeters (12 inches).

Site

Elevation of this community ranges between 1 830 and 2 300 meters (6,000 and 7,500 ft) in southeastern Oregon. It may occur near the top of mountains or on the middle, lower, toe, and bottom slopes; it often occurs around springs, seeps, lakes, ponds, or along streams on slopes from 0 to 30 percent. Some stands are extensive, occurring adjacent to and parallel with streams in unbroken bands up to 150 meters (500 ft) wide and several hundred meters long. Other stands are small patches of less than 1 hectare (2.5 acres) in size.

[5]J. Edward Dealy, unpublished data on file at Range and Wildlife Habitat Laboratory, La Grande, Oregon.

[6]Personal communication from A. H. Winward, Oregon State University, Corvallis.

Soil

Soils are moderately deep to deep, gravelly silt loams and loams. Cobble and stone volume in the soil varies, and coarse fragments on the surface are scarce. These soils are well drained, runoff is medium, and erosion hazard is moderate.

Discussion

Most stands have been intensively grazed by livestock for nearly 100 years. Since these sites are highly productive and found near water, wild and domestic ungulates concentrate on them. Reproduction of aspen on streamsides is damaged by grazing, except in areas where access by livestock has been restricted.

Beavers inhabit this community where there is sufficient running water. Damage to aspen reproduction by livestock and wild ungulates and to older trees by beavers has eliminated some stands, thereby eliminating beaver habitat. In one area, for example, there was one active beaver pond, one being built in an aspen stand too small to support the beaver, and approximately 15 abandoned ponds where aspen stands have been eliminated. It did not appear that these destroyed stands would become reestablished (see footnote 5).

Aspen stands provide valuable thermal and hiding cover for many vertebrate species, and nesting sites for birds, including cavity nesters.

3—QUAKING ASPEN/MOUNTAIN BIG SAGEBRUSH (fig. 10)

Vegetation

A single species tree stand of quaking aspen is typical of this community. It usually occurs as an open stand with less than 50-percent crown cover. Height ranges from 6 to 12 meters (20 to 40 ft), and trees on these sites often appear stunted and broad crowned with heavy lateral branches (see footnote 5). Occasionally, all mature trees in this type are either dying or dead. Some stands have a dead (snag) overstory above live reproduction, but in other

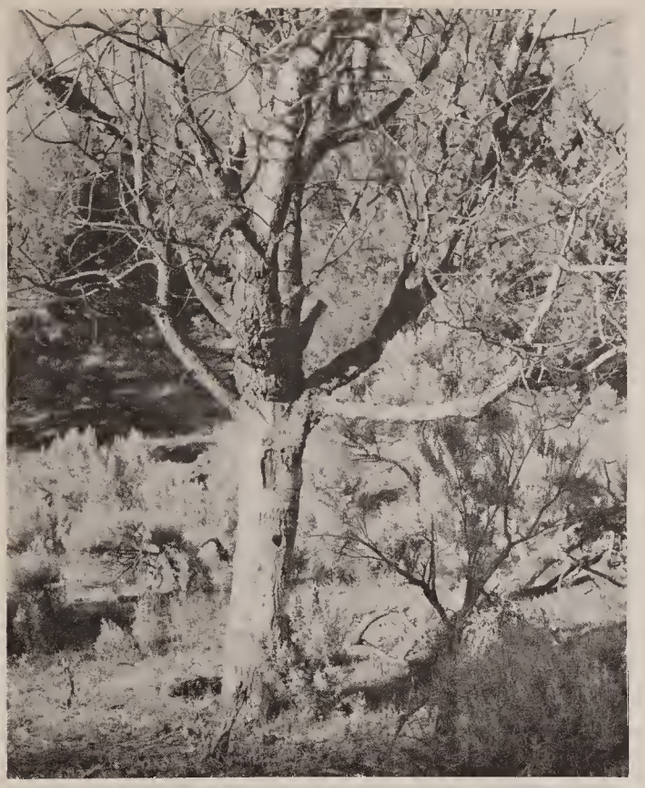

Figure 10.—Quaking aspen/mountain big sagebrush community illustrating the common branched tree form. Note the hole in the trunk used by cavity nesters (Chris Maser photograph).

stands both layers are dead. The causes of such mortality are unknown. It does appear, however, that these sites are marginal, and fluctuation in underground moisture or winter snowpack may be important factors. Also, long-term concentrated use of these small areas for forage and shade by livestock and big game may have consistently destroyed reproduction and prevented replacement of the old, degenerating stand.

Crown cover of quaking aspen reproduction ranges from 25 to 75 percent, and all heights may be represented, from a few centimeters to mature height. It is common, however, to see the aspen reproduction, where present, dominated by a single age and height class.

Mountain big sagebrush is the dominant shrub, with crown cover ranging from 15 to 40 percent. Average height is approximately 1 meter (3.28 ft). Gray rabbitbrush is the next most abundant shrub and may have crown cover as high as 20 percent. Green rabbitbrush is a consistent but sparse component; it increases in density, however, as moisture availability increases in severely grazed communities (see footnote 5).

Common perennial grasses and grasslike plants in disturbed stands of this type, in descending order of amounts of crown cover, are needlegrass, bottlebrush squirreltail, wheatgrass, and sedge. Annual cheatgrass is also common. Total crown cover of these species is less than 10 percent. Mean heights of needlegrass and wheatgrass are 50 and 60 centimeters (20 and 24 inches), respectively. Bottlebrush squirreltail and cheatgrass both average 25 centimeters (10 inches) in height, whereas sedge averages 5 centimeters (2 inches) (see footnote 5).

Forbs are sparse. Thistle and aster appear as occasional plants, and common dandelion is a rare component. Their total crown cover is generally less than 1 percent (see footnote 5).

Site

The quaking aspen/mountain big sagebrush community occurs most commonly on what appear to be dry sites between 1 550 and 2 150 meters (5,000 and 7,000 ft). It is present both in the Owyhee Uplands and Basin and Range Provinces (Franklin and Dyrness 1973). Macrorelief is mountainous and microrelief smooth. Slope ranges from less than 5 to 25 percent, and the position on a slope may be upper, middle, or lower. Slope aspects are generally northerly—from north-northwest to east-northeast (see footnote 5).

Soil

Soils are moderately deep, gravelly loams to sandy loams overlying basalt or rhyolite. They are well drained, and erosion hazard is moderate. Cobble and stone volume in the soil ranges from 5 to 30 percent, and coarse fragments cover less than 5 percent of the soil surface (see footnote 5).

Discussion

This quaking aspen community indicates a high soil moisture level, possibly caused by the combination of an unusual underground source of water and an exceptionally heavy snowpack.

All observed sites occur near maximum elevations on aspects roughly 180° from prevailing winter storm winds. Snowpack is deep and persistent compared with surrounding sites.

Use by livestock is intense in this community because of its high production of forage and tree shade. These stands are small; relative to the overall livestock forage resource of the adjacent open range, they have little impact. They appear to be important, however, as islands that maintain habitat diversity for wildlife and, therefore, merit management.

Curlleaf Mountainmahogany Communities (figs. 11 and 12)

Curlleaf mountainmahogany has two recognized varieties in the intermountain west. Only *Cercocarpus ledifolius* var. *ledifolius* is commonly present in the Great Basin of southeastern Oregon, occurring within four broad community groups: tree-sagebrush-bunchgrass, tree-snowberry-grass, tree-bunchgrass, and tree-grass (Dealy 1971, 1975).

Figure 11.—Extensive stands of curlleaf mountainmahogany blanket the tops and slopes of high desert mountains. Communities with open stands and understories of mountain big sagebrush differ from those with dense-canopied stands and a grass understory. Vegetation changes depend on changes in aspect and elevation which produce changes in available moisture.

Figure 12.—Dense curlleaf mountainmahogany stand upslope from a vigorous mountain big sagebrush stand. These two high value habitats commonly occur adjacent to one another and, as a result, increase diversity for deer (in foreground) and other wildlife. Precipitation is above 50 centimeters (20 inches).

4—CURLLEAF MOUNTAINMAHOGANY/ MOUNTAIN BIG SAGEBRUSH/ BUNCHGRASS (fig. 13)

Vegetation

This community is characterized by a patchy distribution of curlleaf mountainmahogany with a crown cover ranging from 35 to 60 percent and averaging 50 percent. Tree density varies between 800 and 2,000 stems per hectare (300 and 800 per acre) and averages 1,250 per hectare (500 per acre) with an occasional interspersed western juniper. Occasionally, ponderosa pine may occur within the stands.

The shrubby understory usually consists of a mountain big sagebrush layer of less than 5-percent crown cover. Density and vigor of sagebrush increase noticeably in the spaces between trees. Gray rabbitbrush, green rabbitbrush, wax currant, and Wyeth eriogonum are less common in the shrub layer.

Figure 13.—Curlleaf mountainmahogany/mountain big sagebrush/bunchgrass community in the Great Basin of southeastern Oregon. Mountain big sagebrush grows densely and with high vigor under open tree canopies.

Dominant grasses are Idaho fescue, cutting wheatgrass, and big bluegrass. Other common grasses or grasslike species are California brome, bottlebrush squirreltail, Lemmon needlegrass, and Ross sedge.

Between 20 and 30 forbs occur in the understory. Lambstongue groundsel, arrowleaf balsamroot, western hawkweed, lupine, violet, and annual agoseris are most common.

Site

The curlleaf mountainmahogany/mountain big sagebrush/bunchgrass community occurs mostly on southerly facing slopes, ranging from 0 to 40 percent at elevations of 1 600 to 1 950 meters (5,250 to 6,400 ft). Mean elevation is 1 750 meters (5,750 ft). Macrorelief is mountainous and microrelief smooth. Since local topography in some areas is abruptly broken by ridges and hillocks, directional aspects may change within short distances.

Stands of this community occur on the driest sites suited to curlleaf mountainmahogany in the high desert mountains. When situated as narrow stringers on rimrock sites, the stands characteristically contain fewer species and some atypical species because of ecotonal influences within the narrow strip of the type.

Soil

The soil is well drained and varies from gravelly loam to gravelly sandy loam in the A horizon, and from gravelly clay loam to fine sandy loam in the B or AC horizon. Soil depth varies from 23 to 85 centimeters (9 to 33 inches) and averages 55 centimeters (22 inches). Soil surface cover of coarse fragments ranges from 1 to 60 percent and averages 32 percent. Cobble and stone volume in the soil ranges from 25 to 90 percent and averages 68 percent. Parent material can be either residuum or colluvium. Underlying material is generally either basalt or rhyolite. The soil is often shallow in stringer sites adjacent to rimrock, and stoniness of these soils is generally pronounced (Dealy 1975).

Discussion

This community has had a long history of heavy use by livestock—sheep in the early days and cattle more recently. This has resulted in an increase of understory species, such as gray or green rabbitbrush, cheatgrass, bottlebrush squirreltail, Lemmon stipa, or thistle. Generally, stands occur in a mosaic with mountain big sagebrush where relatively dense clumps of curlleaf mountainmahogany are interspersed with openings dominated by sagebrush and bunchgrass.

Fire easily kills curlleaf mountainmahogany. In many instances, patterns of burning are indicated by old, large trees in rocky, fire-resistant sites adjacent to young (60-80 year) stands in less rocky sites more vulnerable to fire. The old trees appear to have been missed by fire and provided the seed to reestablish adjacent stands. Many curlleaf mountainmahogany stands appear to have increased in size since fire has been controlled (Dealy 1975). Such action has been an advantage to wildlife in general since these stands provide important hiding and thermal cover for deer and bighorn sheep, as well as nesting sites for birds and ground-dwelling mammals.

5—CURLLEAF MOUNTAINMAHOGANY/ MOUNTAIN SNOWBERRY/GRASS

Vegetation

Stands of the curlleaf mountainmahogany/ mountain snowberry/grass community are characterized by a tree crown cover, ranging from 50 to 85 percent and averaging 70 percent. Such stands may vary in size from a few hectares to extensive areas with only small interspaces that may be dominated by grasses or shrubs (often mountain big sagebrush). Tree density varies from 900 to 3,200 stems per hectare (365 to 1,300 per acre) and averages 1,770 per hectare (720 per acre). An occasional western juniper may occur and, rarely, quaking aspen on moister sites (Dealy 1975).

The shrub understory commonly is a mixture of mountain snowberry and mountain big sagebrush. Dominance may change from one to the other in different stands. Crown cover is generally less than 5 percent. Other shrubs commonly found are green rabbitbrush, gray rabbitbrush, chokecherry, and creeping Oregon grape. Saskatoon serviceberry is present on about 50 percent of the area sampled. Other less commonly occurring shrubs are bittercherry and desert rockspirea.

Dominant grasses and grasslike species are big bluegrass or Idaho fescue in stands lightly used by livestock. Ross sedge and Sandberg bluegrass are common in most stands of the complex. In stands heavily used by livestock, there is an increase in bottlebrush squirreltail, cheatgrass, and Sandberg bluegrass.

Dominant forb species vary among sites in this community. Common species on dry sites are balsamroot, lupine, prairiesmoke avens, and varileaf phacelia; on moist sites—gray hawksbeard, heartleaf arnica, meadowrue, lambstongue groundsel, and Holboell rockcress.

Site

The driest stands of this community occupy south to southwest slopes at elevations averaging 1 770 meters (5,800 ft). Slopes average 30 percent.

Other stands are found on northerly aspects, varying from east-northeast to northwest at elevations between 1 800 and 1 900 meters (5,900 and 6,232 ft). Slopes range from 25 to 35 percent. Macrorelief is mountainous; microrelief generally rough. Topography is steep and abrupt in some stands and moderate in others.

Soil

Soils range from shallow to moderately deep and from a loam texture to gravelly loam. Cobble and stone cover of the soil surface ranges from 5 to 48 percent, and cobble and stone volume in the soil ranges from 27 to 81 percent. Parent material is generally colluvium or a mixture of colluvium and residuum material. Some soils overlay basalt; others occur over rhyolite (Dealy 1975).

Discussion

Density, vigor, and size of shrubs appear to be either a function of available moisture or an interaction of available moisture and tree crown cover (reduction of light) on the drier sites. Under dense tree canopies, shrubs are small, structurally weak, and scattered. In more open stands, however, shrubs are larger, more vigorous, and more dense. Increased available moisture within sites favors an increase in grasses and forbs rather than shrubs.

Stands of the community are habitat for mule deer and bighorn sheep. Livestock have also used these areas since the 1860's.

Fire control has permitted development, maintenance, and expansion of tree stands within the curlleaf mountainmahogany/mountain snowberry/grass community (Dealy 1975).

6, 7—CURLLEAF MOUNTAINMAHOGANY/ IDAHO FESCUE (fig. 14) AND CURLLEAF MOUNTAINMAHOGANY/BEARDED BLUEBUNCH WHEATGRASS-IDAHO FESCUE (fig. 15)

Vegetation

Tree cover varies from an average 66 percent in stands on the moister sites to 36

Figure 14.—Curlleaf mountainmahogany/ Idaho fescue community commonly occurs adjacent to the ponderosa pine zone on moist northerly sites.

Figure 15.—Curlleaf mountainmahogany/ bearded bluebunch wheatgrass-Idaho fescue community commonly occurs below and adjacent to the lower edge of the ponderosa pine zone.

percent on drier sites. Curlleaf mountainmahogany is the dominant species, but ponderosa pine occurs as scattered trees where the community is adjacent to the pine zone. Western juniper occurs as a subordinate species in some stands. Density of curlleaf mountainmahogany ranges from 500 to 2,000 stems per hectare (200 to 800 per acre). Stands are either patchy in distribution or occur as narrow bands perpendicular to the slope below and adjacent to the ponderosa pine zone. They occasionally encircle scab flats as bands within a ponderosa pine forest.

The shrub layer consists of occasional big sagebrush plants and rare plants of wax currant, gray rabbitbrush, green rabbitbrush, or antelope bitterbrush.

Grasses and grasslike species on sites indicating highest soil moisture are Idaho fescue (a strong dominant), bearded bluebunch wheatgrass, bottlebrush squirreltail, prairie junegrass, Sandberg bluegrass, California brome, Ross sedge, and cheatgrass. On drier sites, understories are bearded bluebunch wheatgrass and Idaho fescue in a codominant relationship. Both Sandberg bluegrass and bottlebrush squirreltail are more abundant, and prairie junegrass and cheatgrass remain about the same as on moist sites.

Forbs are scarce in the understory. Western hawkweed and phlox are most common on moist sites, and arrowleaf balsamroot is most common on drier sites. Occasional forbs are yarrow and annual agoseris.

Site

The curlleaf mountainmahogany/Idaho fescue community is found on most aspects from 1 600- to 1 700-meter elevation (5,250 to 5,575 ft). Northerly slopes ranging from 5 to 15 percent contain a dominant understory of Idaho fescue, whereas on other aspects with slopes ranging from 25 to 60 percent, bearded bluebunch wheatgrass and Idaho fescue are codominant. Macrorelief is mountainous, and microrelief varies from smooth to rough.

Soil

Soils are generally moderately deep, well-drained loams. Cobble and stone volume in the A horizon ranges from 5 percent where Idaho fescue is dominant to 30 percent where bearded bluebunch wheatgrass is codominant with Idaho fescue. Cobble and stone volume in B horizons is about 65 percent. Soils are developed from colluvium or weathered basalt. Permeability is moderate, runoff is estimated as medium, and erosion hazard is moderate (Dealy 1975).

Discussion

Use by cattle is minor in these stands because dense (70-percent crown cover), short stands of curlleaf mountainmahogany form a natural physical barrier. The trees commonly retain dead lateral branches below the live canopy. In a dense stand, these brittle but tough branches make penetration by cattle difficult. Domestic sheep travel through these thickets, however, as evidenced by wool hanging from low branches (Dealy 1971).

Tree crown cover averages 35 percent on sites having a high percentage of bearded bluebunch wheatgrass. Cattle move readily within these stands to graze the understory.

Mule deer use all sites for cover and forage; these sites, however, are more important to deer for cover than for forage (Dealy 1971).

8—CURLLEAF MOUNTAINMAHOGANY/ PINEGRASS (fig. 16)

Vegetation

Curlleaf mountainmahogany/pinegrass stands contain only one other tree species—an occasional bittercherry. Crown cover ranges from 62 to 96 percent and averages 80 percent. Density ranges from 1,400 to 4,700 stems per hectare (570 to 1,900 per acre) and averages 2,000 stems per hectare (800 per acre).

Shrubs are sparse; Saskatoon serviceberry and creeping Oregon grape are almost always present. Occasional shrubs are green rabbitbrush, gray rabbitbrush, and Wyeth eriogonum.

Pinegrass dominates the grass layer in light to moderately grazed stands. Big bluegrass is abundant, and Ross sedge, bottlebrush squirreltail, and cutting wheatgrass are common. Either Idaho fescue or Lemmon needlegrass is codominant with pinegrass in stands that have been heavily grazed by livestock. Other common grass and grasslike species in these heavily used stands are bottlebrush squirreltail, big bluegrass, and Ross sedge.

Western hawkweed is the dominant forb on relatively undisturbed sites. On disturbed sites, Nuttall violet dominates, western hawkweed is found consistently in low abundance, and thistle and common dandelion increase with disturbance. Common forbs on all sites are prairiesmoke avens, annual agoseris, and yarrow.

Figure 16.—The curlleaf mountainmahogany/pinegrass community has the highest potential for production of dry land species in the Great Basin of southeastern Oregon.

The Alaska habenaria (commonly called Alaska rein-orchid) grows in low abundance in stands showing no evidence of litter disturbance. This plant develops a fleshy tuber delicately attached just below the interface of litter and mineral soil. It appears in stands protected from livestock and wild ungulate trampling by a dense tree thicket but disappears from sites where the litter-soil interface is even slightly disturbed (Dealy 1975).

Site

The curlleaf mountainmahogany/pinegrass community has been identified in the Owyhee Uplands (Dealy 1975) at elevations ranging from 1 750 to 1 920 meters (5,750 to 6,300 ft). It consistently occupies slopes facing east-northeast to north. Slopes range from 10 to 40 percent and average 24 percent. Macrorelief is mountainous, microrelief smooth. These sites experience heavy snowpacks during most winters. Measurements over a period of years have established annual precipitation at 56 centimeters (22 inches) (Dealy 1975).

Soil

Soils are moderately deep (48 centimeters or 19 inches), varying from gravelly loams to gravelly sandy loams, overlying fractured rhyolitic bedrock. Parent material is residual. Cobble and stone cover of the soil surface ranges from 0 to 10 percent and averages 3 percent; cobble and stone volume in the soil profile ranges from 15 to 80 percent and averages 44 percent. Soils under this community are well drained and moderately permeable. Runoff is medium and erosion hazard moderate to high (Dealy 1975).

Discussion

Domestic sheep and cattle grazing in the Owyhee Uplands, where this community occurs, was moderate to heavy during the late 1800's and early 1900's (Griffiths 1902). Since 1934, cattle have been the primary domestic animals grazing in the area. Historically, bighorn sheep and mule deer inhabited the area. Bighorn sheep were eliminated, however, near the turn of the century and did not return until 1965, when the Oregon Department of Fish and Wildlife reestablished them in some mountainous areas. Mule deer have been present throughout recorded history.

The curlleaf mountainmahogany/pinegrass community exhibits what may be the highest potential for production of dry land species in the high desert mountains of the northern Great Basin. Stands of this community where the Alaska habenaria occurs appear to be closer to pristine conditions than any others. This community is particularly valuable to birds and small ground-dwelling vertebrates.

Western Juniper Communities

Western juniper is unique to the intermountain west. Its center of development is the large woodland of central Oregon. It also occurs throughout southeastern Oregon, southwestern Idaho, northwestern Nevada, and northeastern California in scattered, open stands, as single trees, and rarely in more dense, extensive stands (Dealy et al. 1978a, 1978b) (fig. 17).

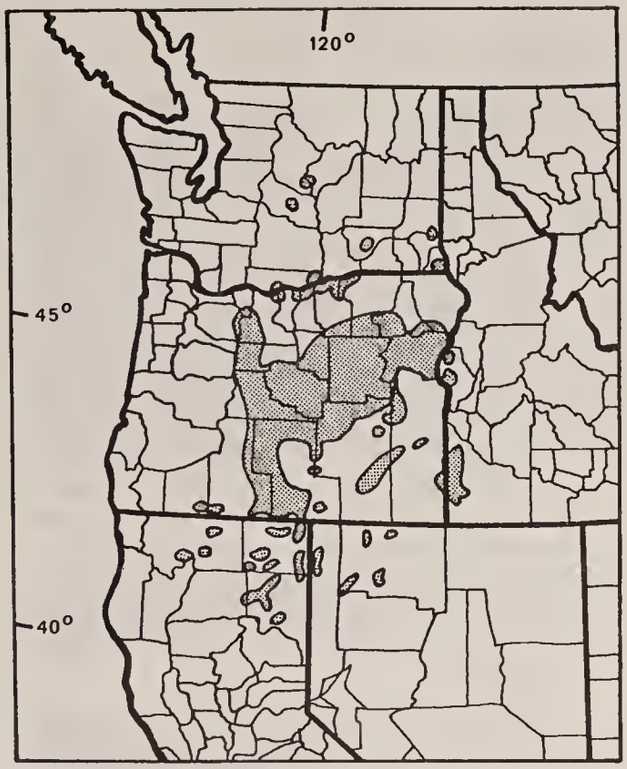

Figure 17.—Generalized distribution of western juniper (shaded portion) which occurs only in the Northwest (from Dealy et al. 1978a). Tree densities vary within and among the different localities.

9, 10—WESTERN JUNIPER/BIG SAGEBRUSH/BEARDED BLUEBUNCH WHEATGRASS (fig. 18) AND WESTERN JUNIPER/BIG SAGEBRUSH/IDAHO FESCUE

Vegetation

Western juniper in stands of these communities occurs primarily as a single overstory species with wide spacing. Some stands occur with a mature overstory, whereas others have recently developed with a young overstory on sites previously occupied by big sagebrush communities (fig. 19). Crown cover of western juniper is less than 35 percent in most stands.[7] Big sagebrush is the dominant shrub; gray rabbitbrush and green rabbitbrush are present in varying amounts. On moist sites, the shrub layer becomes less dominant and both western juniper and grass increase in importance. Occasionally, antelope bitterbrush and broom snakeweed are present (Driscoll 1964, Eckert 1957).

[7]Donavin A. Leckenby, Oregon Department of Fish and Wildlife, La Grande, Oregon, unpublished data.

Figure 18.—Western juniper/big sagebrush/bearded bluebunch wheatgrass community illustrating a mature stand of open juniper. Value as protective cover is high for ungulates, small mammals, birds, and other wildlife in the juniper communities.

Figure 19.—Before fire control and livestock grazing, this area supported a mountain big sagebrush/bunchgrass community. All western juniper trees here have become established since fire control and grazing (reduces grass fuel) reduced the frequency of fires.

Dominant grasses are bearded bluebunch wheatgrass or Idaho fescue. On some sites these grasses appear as codominants. Common grasses are Thurber needlegrass, bottlebrush squirreltail, Sandberg bluegrass, and cheatgrass. Burkhardt and Tisdale (1969) also found these grasses in the western juniper type in southwest Idaho. Occasionally plants of prairie junegrass and needleandthread occur in Idaho and Oregon stands (Burkhardt and Tisdale 1969, Roberts 1975; also see footnote 7).

Forbs in the juniper community include the following: locoweed, phlox, biscuitroot, fleabane, buckwheat, pussytoes, hawksbeard, annual agoseris, rockcress, arrowleaf balsamroot, and lambstongue groundsel.

Driscoll (1964) made an intensive study of western juniper communities, describing vegetation, site, and soils of nine associations and two variants in central Oregon. Three of these associations—western juniper/Idaho fescue, western juniper/bearded bluebunch wheatgrass, and western juniper/bearded bluebunch wheatgrass-Idaho fescue—have understories dominated by grass. The other six have understories with prominent big sagebrush layers, and the two variants have prominent antelope bitterbrush layers. Tables 3 and 4 list Driscoll's (1964) associations and present selected information on vegetation, site, and soil. Similar communities have been studied in south-central Oregon (Adams 1975, Roberts 1975). Intensive studies on western juniper communities are lacking for southeastern Oregon. Vegetation-site relationships, including plant and community structure, can be applied from Driscoll's (1964) work where similar conditions are found.

Site

The western juniper/big sagebrush/bearded bluebunch wheatgrass and western juniper/big sagebrush/Idaho fescue communities occupy level to hilly sites and ridges and northerly slopes in mountainous areas where moisture levels are higher than in the sagebrush steppe. Western juniper, as a type, occurs just below and abuts the curlleaf mountainmahogany zone. Precipitation ranges from approximately 25 to 38 centimeters (10 to 15 inches) per year. Macrorelief is level to mountainous, and microrelief can be rough in rimrock situations or smooth in deeper soils. Idaho fescue dominates the understory on sites with highest moisture, and bearded bluebunch wheatgrass is dominant on the driest sites. A more varied mixture of these grasses is found on sites of intermediate moisture.

Table 3—Number of macroplots and generalized characteristics of vegetation-soil units in the central Oregon juniper zone; reproduced from Driscoll (table 2, 1964)

Unit	Sample units	Aspect	Associated great soil group	Elevational range
		Number		Feet
Juniperus/Artemisia/Festuca	5	NW. to NE.	Chestnut	4,250-4,500
Juniperus/Artemisia/Festuca-Lupinus	4	N. to NE.	Regosol in Brown zone	4,400-4,550
Juniperus/Festuca (*Purshia* variant)	5 (2)	NW. (SE. to E.)	Brown	4,100-4,300
Juniperus/Artemisia/Agropyron-Chaenactis	5	NW. to NE.	Regosol in Brown zone	3,900-4,400
Juniperus/Artemisia/Agropyron	5	Level	Brown	2,550-2,650
Juniperus/Agropyron (*Purshia* variant)	6 (2)	E. to NE. (SE.)	Brown	4,150-4,450
Juniperus/Artemisia-Purshia	5	N. to NE.	Regosol in Brown zone	4,100-4,400
Juniperus/Agropyron-Festuca	5	E.	Regosol in Brown zone	4,250-4,750
Juniperus/Artemisia/Agropyron-Astragalus	6	S. to SW.	Brown	4,000-4,400

Table 4—Average values of selected surface and subsoil characteristics attendant to nine associations in the central Oregon juniper zone; reproduced from Driscoll (table 3, 1964)

Association	Basal area perennial herbs	Bare soil surface	Available SMS[1] capacity, 2- to 14-inch zone	Organic matter, A horizon	Total nitrogen, A horizon	Horizon texture[2]	
						A	B or AC
	Percent	Percent	Inches water	Percent	Percent		
Juniperus/Artemisia/Festuca-Lupinus	7.4	22.1	1.41	4.78	0.21	l	c
Juniperus/Artemisia/Festuca-Lupinus	6.5	30.9	1.98	1.74	.10	sl	sl
Juniperus/Festuca (*Purshia* variant)	4.4	33.3 (46.8)	1.81 (2.14)	3.91 (2.33)	.17 (.10)	l (l)	sil, c (c)
Juniperus/Artemisia/Agropyron-Chaenactis	5.2	52.3	.87	1.59	.08	sl	sl
Juniperus/Artemisia/Agropyron	6.6	41.3	2.31	1.50	.08	l	c, cl
Juniperus/Agropyron (*Purshia* variant)	3.2	51.1	1.34	2.12	.10	scl (l)	c, cl
Juniperus/Artemisia-Purshia	3.1	55.0	1.54	1.05	.06	sl	sl
Juniperus/Agropyron-Festuca	4.1	54.7	.97	1.32	.07	sl	sl
Juniperus/Artemisia/Agropyron-Astragalus	3.5	45.7	1.21	1.63	.08	l	c

[1] SMS, soil moisture storage.
[2] The AC horizon is immediately below the A horizon in Regosols. B horizon textures were taken for the finest part of that horizon. Textural classes: cl, clay loam; l, loam; scl, sandy clay loam; sil, silt loam; c, clay; and sl, sandy loam.

Soil

Soils are highly variable in western juniper communities. Relatively young stands (100 years old or younger) have been reported on deep sandy loam soils in areas supporting the big sagebrush type before advent of fire control (Burkhardt and Tisdale 1969, 1976). Old-growth stands (more than 100 years) have been found on rocky rims having shallow soils. Eckert (1957), working in southeastern Oregon, found soils supporting western juniper to be in the Brown and Chestnut great soil groups that were derived primarily from residuum or colluvium of basalt and rhyolite origin. Some, however, developed on alluvial fans. Soil profiles were similar in many respects to those described by Dealy et al. (1978a, 1978b) and Driscoll (1964).

Discussion

Some authors have described western juniper as an "invader" in certain big sagebrush communities (Anderson 1956; Burkhardt and Tisdale 1969, 1976). Western juniper appears to be a strongly dominant native species but historically has been kept in a subordinate role on some sites because of natural fires (Dealy et al. 1978a, 1978b). Since fire control has been in effect and since severe livestock grazing began in the late 1800's, resulting in reduced grass-forb fuel for carrying fires, western juniper has increased its range and density in some areas

(fig. 19). Whether the increase of western juniper communities is an "invasion" or an "expansion" is important semantically because "invasion" has a negative connotation. It is more important that managers objectively recognize values of western juniper communities and retain them, if desired; this is consistent with the strategy of preserved diversity (Bella and Overton 1972).

The western juniper community is important for livestock production because of available shade, wildlife habitat (Leckenby 1977, 1978b; Maser and Gashwiler 1978), recreational activities, and erosion protection, to name a few values. A provisional list of 83 species of birds and 23 species of mammals that use western juniper communities was developed by Maser and Gashwiler (1978). The importance of thermal qualities of western juniper communities for mule deer has been documented by Leckenby (1977). Old-growth stands of western juniper provide a special habitat for cavity dwellers, such as the bushy-tailed woodrat (fig. 20).

Figure 20.—Nests of bushy-tailed woodrats in a hollow western juniper stem illustrate one of the many values of old growth for wildlife habitat (Chris Maser photograph).

Sagebrush Communities

Woody sagebrushes dominate the aspect (physiognomy) of the high desert shrub-steppe plant communities. These shrubs are distributed from Canada to Mexico and from the Pacific Northwest States to the Great Plains (Beetle 1960).

Aromatic gray sagebrushes appear as at least 13 distinctive taxa in Oregon. Among other characteristics, habitat, height, branching form, leaf shape, chromosome number, chromatographic response, and fluorescence in ultraviolet light help to identify the various important taxa (Beetle 1960; Hanks et al. 1971, 1973; Stevens and McArthur 1974; Winward 1980; Winward and Tisdale 1977). The above characteristics except chromosome number and chromatographic response, can be used in the field for identification of taxon. Heights of sagebrushes vary between extremes of the tall basin big sagebrush and the small bud sagebrush. Height of other species and subspecies declines between those extremes in about the following order: (1) subalpine big sagebrush, (2) mountain big sagebrush, (3) Wyoming big sagebrush, (4) mountain silver sagebrush, (5) Bolander silver sagebrush, (6) threetip sagebrush, (7) stiff sagebrush, (8) early low sagebrush, (9) low sagebrush, and (10) black sagebrush (see footnote 6, p. 18). Branching appears feathery and upright in basin big sagebrush and silver sagebrushes, tabular and compact in mountain big sagebrush, and globelike or flattened in black sagebrush (fig. 21). Leaves are predominantly wedge shaped, with three lobes (occasionally five or more) at the wide tip; silver sagebrush leaves are tapered to one tip, like lance points. Alcohol or water extracts of the leaves and other parts fluoresce characteristic shades of creamish-blue or brownish-red (table 5) in long-wave ultraviolet light (Stevens and McArthur 1974, Winward 1980, Winward and Tisdale 1977).

The various sagebrushes readily cross (genetic plasticity), as evidenced by similarities among their morphological characteristics (Beetle 1960).

At least four, and probably more, sagebrush taxa reach the same growth stages

Figure 21.—Three major growth forms of sagebrushes: A, feathery and upright; B, tabular and compact; and C, globular or flattened.

Table 5—Characteristic color shades of alcohol extracts of persistent leaves of 12 sagebrushes during exposure to long-wave ultraviolet light (after Winward 1980)

Sagebrush taxa	Shade of fluorescence	
	Creamish-blue	Brownish-red
Basin big sagebrush		X
Wyoming big sagebrush		X
Stiff sagebrush		X
Black sagebrush		X
Mountain big sagebrush	X	
Subalpine big sagebrush	X	
Threetip sagebrush	X	
Bolander silver sagebrush	X	
Mountain silver sagebrush	X	
Low sagebrush	X	
Cleftleaf sagebrush	X	
Early low sagebrush	X	

(phenology) at different times. For example, mountain big sagebrush initiates growth 2 weeks later and ripens seed 2 weeks earlier than basin or Wyoming big sagebrush; subalpine big sagebrush initiates growth later and seed development earlier than any other taxon; differences between basin and Wyoming big sagebrushes are not consistent (Winward and Tisdale 1977).

Winward and Tisdale (1977) discussed several management reasons for identifying sagebrushes to subspecies. Briefly, the various taxa of sagebrush provide indicators for (1) recognition of the plant environment or site (climate, soil, and other factors); (2) estimation of productive potential; (3) prediction of reaction to disturbance (changes in plant composition or stand structure); (4) determination of

range condition; (5) evaluation of forage preferences among stands; (6) applications of grazing systems; and (7) selection of treatment methods and schedules appropriate to accomplishment of management goals.

Sagebrushes can be separated conveniently into tall and short groups based on species, subspecies, and form. Each group requires different manipulations to meet management objectives for forage or cover. The tall sagebrush group is comprised of basin big sagebrush, mountain big sagebrush, Wyoming big sagebrush, subalpine big sagebrush, threetip sagebrush, mountain silver sagebrush, Bolander silver sagebrush, and other as yet undefined taxa. The short sagebrush group is comprised of low sagebrush, cleftleaf sagebrush, early low sagebrush, black sagebrush, stiff sagebrush, bud sagebrush, and other as yet undefined or unidentified taxa.

The recognition of species, subspecies, and forms of sagebrush supplies much information about a stand or a community—much that would take years to measure by other means; for example, weather stations. Variation in composition of plants among stands may identify differences in environments (Fosberg and Hironaka 1964); for example, stands of silver sagebrush, low sagebrush, and big sagebrush are usually separated by sharp ecotones because these species greatly differ in tolerance to soil moisture saturation. Silver sagebrush survives flooding and soil saturation longer than low sagebrush, and both silver and low sagebrush survive soil saturation better than big sagebrush. Tolerances for given environmental conditions vary even within species: Bolander silver sagebrush is more tolerant of alkalinity than is mountain silver sagebrush and occurs in closed basins; Wyoming big sagebrush is more tolerant of finer textured, alkaline soils than is basin big sagebrush and therefore dominates it on such sites.

The effect of climate on broad patterns of plant distribution is well accepted, and this effect is usually described and predicted by single factor relationships. For example, "Mean annual precipitation is never more than 363 mm in the *Artemisia* zone and never less than 408 mm in the *Pinus* forest" (Daubenmire 1956, p. 142); these moisture levels defined the sagebrush-forest ecotone in portions of Washington and Idaho. In another example, the threetip sagebrush-fescue zone is separated from a big sagebrush-wheatgrass zone and is associated with cooler temperatures from October through April and with higher precipitation and water balances in September, November, December, January, and March (Daubenmire 1970).

Microclimate is closely reflected by many plant species, and most of these are probably *not* dominants in the stand.

Grazing management has a marked influence on densities and crown cover of sagebrushes and cheatgrass.

Unusual and prolonged increases in soil moisture (i.e., water spreading as a management tool) drastically alter the relative dominance of western juniper, sagebrushes, and grasses. If flooding is of sufficient duration, pygmy woodlands and shrub steppes are converted to meadows or marshlike plant communities. Again, the characteristic species within the stand reflect the management. Not all interactions are obvious. There is still much to learn about a site from composition of plant species and how best to manage the site for specific goals (Daubenmire 1968, Pechanec et al. 1965).

Community composition reflects quality of forage, and community structure reflects quality of cover. Foraging animals preferentially browse some sagebrush species and subspecies more than others (Sheehy 1975; Smith 1950, 1952); cattle, domestic sheep, and pronghorns favor black sagebrush more than big sagebrush (Dayton 1931). In another study, mule deer and domestic sheep preferred mountain big sagebrush, Bolander silver sagebrush, and low sagebrush; the mule deer ate but did not prefer Wyoming and basin big sagebrush and showed the least preference for black sagebrush (Sheehy 1975). Chemical composition may influence the palatability of sagebrushes (Short et al. 1972). Sage grouse, horned larks, and pronghorns prefer low sagebrush stands

over big sagebrush stands of the high desert steppe. The taller big sagebrushes provide considerable shelter from the elements for cattle, domestic sheep, mule deer, and sage grouse and nesting sites for many animals. Few mammals and birds are small enough to effectively use the short sagebrush species for cover—thermal or hiding. Since many plant species of the shrub-steppe often comprise both forage and cover, composition of plant species as well as crown cover of stands are measures of site dominance and forage production. Height of vegetation cover and depth of crown, and layering (adventitious rooting from branches in contact with the soil) are attributes that directly create thermal and hiding cover.

Useful information is thus available from identification of the community; its identification is accomplished by means of characteristic plant species. This information can be applied in evaluation, selection, and application of program alternatives for management of that stand (Daubenmire 1968, Küchler 1957).

Sagebrush/bunchgrass communities are broadly distributed as a shrub-steppe type from Canada south through 11 Western States into Mexico (Beetle 1960, Garrison et al. 1977). Extensive areas of the type are found in Washington (5.9 million ha or 14.7 million acres), Oregon (10.9 million ha or 26.9 million acres), Idaho (15.0 million ha or 37.1 million acres), Nevada (13.7 million ha or 33.9 million acres), and California (7.3 million ha or 18.1 million acres) (Beetle 1960).

Stands vary from austere expanses dominated by single species to multihued mosaics rich in species.

Sagebrushes dominate arid, cold desert plains beginning at 30-meter (100-ft) elevation, but similar stands also mingle with moist, subalpine parklands up to 3 050 meters (10,000 ft) in elevation. The stands are distributed down drainages, within basins, up slopes, across plateaus, and along ridge crests.

Associated soils usually fall within either the Brown or Chestnut Great Soil Groups. Some sagebrush stands also occur on Chernozem or Sierozem soils (Fosberg and Hironaka 1964, Tisdale et al. 1969). Species distributions are generally correlated with soil depth and seasonal wetness. Franklin and Dyrness (1973) compiled information published by several authors and compared soils of four major sagebrush species: big sagebrush on deeper soils, low sagebrush on shallow stony soils, stiff sagebrush on very shallow stony soils (lithosols), and silver sagebrush in moister habitats.

Sagebrush communities of the Great Basin are valuable range habitats that help protect as well as produce multiple resources. Sagebrushes comprise a protective cover that minimizes wind and water erosion on many sites. Grazing of livestock is the primary measured economic use of the Great Basin sagebrush zone. Free-ranging big game and other wildlife provide many secondary benefits to society as well as an unmeasured but real economic flow within the region. Because of these values, results from manipulating sagebrush vegetation are important to the short-term and the long-range economic goals of Western States. Every management strategy in manipulating cover and forage qualities of the sagebrush range involves trade-offs in benefits to livestock and wildlife.

11—BASIN BIG SAGEBRUSH/ BUNCHGRASS (fig. 22)

Beetle (1960) described the range of basin big sagebrush in Oregon as extending from the southern end of the Blue Mountains, northeastern Oregon, throughout the central and southeastern portions of the State. Although he also recorded the basin form for every county east of the Cascade Range, Winward (1980) considered its range more restricted than that of other big sagebrush forms. The land area occupied by basin big sagebrush constitutes a minor portion of the sagebrush complex in Oregon; much of its former range is now cultivated land. Over recent history, the distribution has changed little, but various uses have considerably altered the density of stands (Winward and Tisdale 1977).

This tallest of big sagebrush forms is usually upright with erect spreading branches and a definite trunk (fig. 21); occasionally it may be either dwarf or treelike (Beetle 1960,

Figure 22.—A basin big sagebrush/bunchgrass stand illustrating the typical structure of this sagebrush subspecies and an understory that has been intensively grazed for a long time, resulting in reduced density of bunchgrass and an increase of annuals.

Winward and Tisdale 1977). The flower stalks are scattered throughout the irregular top. The persistent leaves are long and relatively narrow, shallow lobed, straight margined, and widest at the lobe tips. Alcohol extracts of the leaves fluoresce brownish-red in long-wave ultraviolet light (Winward 1980).

Vegetation

Diversity of species in some stands creates a rich composition, whereas other stands appear to be almost monotypes. Associated plants that are common enough to be used in naming big sagebrush communities and that also occur with basin big sagebrush are: Sandberg bluegrass, needleandthread, Idaho fescue, bearded bluebunch wheatgrass, giant wildrye, and Thurber needlegrass (Daubenmire 1970, Tisdale et al. 1965, Winward 1980). Franklin and Dyrness (1973, p. 235) compiled information from several workers and demonstrated the variety of plant species associated with big sagebrushes as well as the wide distribution of plants that identify the named communities (table 6). Detailed species lists for big sagebrush/bunchgrass communities where the big sagebrush form is unspecified are available in Concannon (1978), Culver (1964), Dealy (1971), Dean (1960), Eckert (1957, 1958), Hansen (1956), Segura-Bustamante (1970), Urness (1966), and Volland (1976).

Structure varies considerably among big sagebrush stands, and that variability influences their cover and forage qualities. Shrub height, crown cover, and plant density are commonly reported measures of structure of big sagebrush stands (table 7). Other important measures of structure seldom reported are the number and height of layers (vegetation strata) as well as hiding cover quality and crown depth. Many references contain structural measures, but most of these are concerned with big sagebrush in general—not a specific form, such as basin big sagebrush (table 7).

Site

In Oregon, basin big sagebrush is found primarily along valley bottoms and in lower foothill regions between 30 and 2 140 meters (100 and 7,000 ft) in elevation. This subspecies is also common to many sites with dry, shallow soils, southerly to westerly aspects, and at talus perimeters (Beetle 1960, Tisdale et al. 1965, Winward 1980). Basin big sagebrush is also found in valley bottoms and lower foothills from 700 to 2 140 meters (2,500 to 7,000 ft) in Idaho (Winward and Tisdale 1977).

Soil

Soil descriptions for many big sagebrush stands are readily available, but none were found that specified the subspecies of big sagebrush that was present. Winward and Tisdale (1977), however, describe basin big sagebrush in Idaho as "growing in deep, well-drained soils." Our observations indicate the tallest stands of basin big sagebrush (to over 2.4 m or 8 ft in height) grow in deep, well-drained soils alongside rivers and streams in southeastern Oregon. Big sagebrush/bunchgrass communities are common on shallow, moderate, and deep soils. Textures include silty clay loams through fine sandy loam and loamy sands to well-drained pumice sands (Culver 1964, Daubenmire 1970, Dealy 1971, Fosberg and Hironaka 1964, Hall 1973, Tisdale et al. 1965, Urness 1966, Volland 1976). The soil profiles generally show well-developed

Table 6—Characteristic species for *Artemisia* associations[1]

Association	Species group	High Lava Plains	Owyhee Upland	Southern Blue Mountains
Artemisia tridentata/ Agropyron spicatum	Shrubs	*Artemisia tridentata*	*Artemisia tridentata*	
	Grasses	*Agropyron spicatum*	*Agropyron spicatum*	
		Poa sandbergii	*Poa sandbergii*	
	Herbs	*Phlox diffusa*	*Lupinus sericeus*	
		Aster scopulorum	*Lomatium triternatum*	
		Aster canescens	*Lomatium macrocarpum*	
		Chaenactis douglasii	*Zigadenus paniculatus*	
		Collinsia parviflora	*Microseris troximoides*	
		Phlox gracilis	*Astragalus filipes*	
		Lappula redowskii	*Astragalus lentiginosus*	
		Gayophytum ramosissimum		
Artemisia tridentata/ Festuca idahoensis	Shrubs	*Artemisia tridentata*	*Artemisia tridentata*	
		Chrysothamnus viscidiflorus	*Chrysothamnus viscidiflorus*	
		Symphoricarpos rotundifolius		
		Ribes cereum		
		Juniperus occidentalis		
	Grasses	*Festuca idahoensis*	*Festuca idahoensis*	
		Agropyron spicatum	*Agropyron spicatum*	
		Poa sandbergii	*Poa sandbergii*	
		Koeleria cristata	*Sitanion hystrix*	
			Bromus tectorum	
			Elymus cinereus	
	Herbs	*Phlox diffusa*	*Balsamorhiza sagittata*	
		Antennaria corymbosa		
		Calochortus nitidus		
Artemisia tridentata/ Elymus cinereus	Shrubs		*Artemisia tridentata*	
	Grasses	*(mentioned but not described)*	*Elymus cinereus*	
			Poa sandbergii	
			Agropyron spicatum	
			Bromus tectorum	
	Herbs		*Penstemon speciosus*	
			Penstemon cusickii	
			Thlaspi arvense	
			Eriogonum umbellatum	
Artemisia arbuscula/ Agropyron spicatum	Shrubs	*Artemisia arbuscula*	*Artemisia arbuscula*	*Artemisia arbuscula*
		Eriogonum sphaerocephalum		*Purshia tridentata*
		Juniperus occidentalis		
	Grasses	*Agropyron spicatum*	*Agropyron spicatum*	*Agropyron spicatum*
		Poa sandbergii	*Poa sandbergii*	*Poa sandbergii*
		Festuca idahoensis	*Sitanion hystrix*	*Sitanion hystrix*
			Bromus tectorum	
	Herbs	*Phlox diffusa*	*Penstemon aridus*	*Trifolium macrocephalum*
		Erigeron linearis	*Lagophylla ramosissima*	
		Collinsia parviflora		
Artemisia arbuscula/ Festuca idahoensis	Shrubs	*Artemisia arbuscula*	*Artemisia arbuscula*	*Artemisia arbuscula*
		Juniperus occidentalis		
	Grasses	*Festuca idahoensis*	*Festuca idahoensis*	*Festuca idahoensis*
		Agropyron spicatum	*Agropyron spicatum*	*Agropyron spicatum*
		Poa sandbergii	*Poa sandbergii*	*Poa sandbergii*
	Herbs	*Phlox diffusa*	*Arabis holboellii*	*Phlox douglasii*
		Phlox hoodii	*Phlox diffusa*	*Balsamorhiza serrata*
		Phlox longifolia	*Erigeron linearis*	
		Microseris troximoides	*Astragalus miser*	
		Antennaria dimorpha	*Balsamorhiza hookeri*	
		Astragalus stenophyllus	*Agoseris heterophylla*	
		Lupinus saxosus	*Achillea millefolium*	
		Trifolium gymnocarpon	*Haplopappus stenophyllus*	
		Trifolium macrocephalum		
Artemisia rigida/ Poa sandbergii	Shrubs		*Artemisia rigida*	*Artemisia rigida*
	Grasses		*Poa sandbergii*	*Poa sandbergii*
			Bromus tectorum	*Sitanion hystrix*
			Festuca microstachys	
			Agropyron spicatum	
			Sitanion hystrix	
	Herbs		*Mimulus nanus*	*Phlox douglasii*
			Zigadenus paniculatus	

[1]Adapted from Franklin and Dyrness (1973, p. 235).

Table 7—Structural measurements reported for tall sagebrush stands

Taxon	Shrub height		Crown cover[1]	Density			Reference
				Plants	Area		
	Meters	Feet	Percent	Number	Square meters	Square feet	
Big sagebrush	0.4-2.0	1.2-6.6	—	—	—	—	Hitchcock et al. (1955)
	1.1	3.5	13	3-7	9.29	100	Tisdale et al. (1965)
	1.0-2.0	3.3-6.6	13-75	33	1076.00	100	Daubenmire (1970)
	.7	2.2	20-27	—	—	—	Culver (1964)
	.5-.6	1.7-1.9	7-12	11-15	18.58	200	Eckert (1957)
	.3-.7	1-2	7-27	—	—	—	Segura-Bustamante (1970)
	.4-.5	1.2-1.7	16-29	103-147	74.00	800	Urness (1966)
	.2-1.0	.6-3.3	9.8-16.6	.3-4.7	10.76	1	Kornet (1978)
	—	—	15-16	—	—	—	Volland (1976)
	—	—	4-15	—	—	—	Hall (1973)
Basin big sagebrush	.3-2.4	1-8	—	—	—	—	Brunner (1972)
	1.0-5.0	3.3-16.0	—	—	—	—	Beetle (1960)
	—	—	13.2	.057	.09	1	Sheehy (1975)
	1.2-2.4	3.9-7.9	—	—	—	—	Winward and Tisdale (1977)
Mountain big sagebrush	—	—	12	.088	.09	1	Sheehy (1975)
	.3-1.2	1.0-4.0	—	—	—	—	Brunner (1972)
	1.0	3.3	—	—	—	—	Beetle (1960)
Wyoming big sagebrush	.3-.9	1.0-3.0	—	—	—	—	Brunner (1972)
	—	—	8-23	—	—	—	Winward (1980)
	—	—	9.7	.078	.09	1	Sheehy (1975)
	.4-1.0	1.5-3.3	—	—	—	—	Winward and Tisdale (1977)
Threetip sagebrush	.5	1.7	10	14	9.29	100	Tisdale et al. (1965)
	1.0-2.0	3.3-6.6	—	—	—	—	Beetle (1960)
	.2-.6	.6-2.0	—	—	—	—	Hitchcock et al. (1955)
Silver sagebrush	1.5	4.9	—	—	—	—	Beetle (1960)
	.5-1.2	1.6-3.9	—	—	—	—	Peck (1961)
Bolander silver sagebrush	.3-0.6	1.0-3.0	—	—	—	—	Beetle (1960)
	—	—	27.8	.33	.09	1	Sheehy (1975)
Mountain silver sagebrush	1.0	3.3	—	—	—	—	Beetle (1960)

[1]Same as crown canopy, canopy closure, or crown density—the proportion of ground surface covered by shrub crowns as vertically projected, like a shadow.

horizons and often include a very fine-textured B horizon. Brown and Chestnut soils are most commonly associated with big sagebrush communities, but some stands have been found on other soils.

Discussion

The forage value of big sagebrush has been related to the quantity and quality of other browse species within the same or adjacent stands (Dietz and Yeager 1959; Short et al. 1972; Smith 1950, 1952). Use by wildlife varies among taxa of big sagebrush. For example, mule deer and domestic sheep preferred other subspecies to basin big sagebrush (Sheehy 1975, Winward 1980); basin big sagebrush was never grazed in Nevada (Brunner 1972).

Recognition of basin big sagebrush stands can aid the range manager in planning for maintenance or enhancement of cover and forage. Crown cover may increase dramatically because of crown enlargement after disturbance, and in such communities there is a greater potential for herbaceous production, native as well as introduced, than in some other big sagebrush communities (Winward 1980).

Burning of various big sagebrush/bunchgrass stands produces different responses among plant communities; different responses among basin big sagebrush communities should also be expected. Perennial grass cover is increased by burning of big sagebrush/bearded bluebunch wheatgrass stands, but fescue plants are damaged by fire (Daubenmire 1970, Concannon 1978). Fires eliminate big sagebrush and initiate plant successions during which perennial grass dominates the sites for long periods.

The influence of grazing in big sagebrush/bunchgrass stands may vary relative to the dominant form of big sagebrush. Daubenmire (1970) suggested that a big sagebrush/Sandberg bluegrass community did not result from overgrazing or burning of big sagebrush/bearded bluebunch wheatgrass stands. In Oregon, the quantity of Sandberg bluegrass increases as Idaho fescue declines, and this relationship is suggested as a measure of range condition (Tueller 1962). Sandberg bluegrass, along with bottlebrush squirreltail and longleaf phlox, increases as bearded bluebunch wheatgrass declines in burned stands of the big sagebrush/bearded bluebunch wheatgrass community (Concannon 1978). Tisdale et al. (1969) found that big sagebrush/Thurber needlegrass stands changed to big sagebrush/Sandberg bluegrass stands during heavy grazing.

Soils associated with big sagebrush communities influence the use of stands by burrowing mammals, the rooting depth of plants, the patterns of soil moisture through the seasons, and the responses of plants after disturbance. Stone-free soils of big sagebrush/fescue stands were favorable to voles, ground squirrels, and badgers (Daubenmire 1970). Rooting depths were greater or effective moisture was better in big sagebrush/giant wildrye stands compared with adjacent stands of other communities (Culver 1964). Cooler and moister sites were indicated by big sagebrush/fescue stands, but soil moisture was depleted earlier in the needlegrass phase of the big sagebrush/bearded bluebunch wheatgrass community (Eckert 1957). On pumice soils, manipulation of big sagebrush and other disturbances increased undesirable species, such as rabbitbrush, horsebrush, goldenweed, and bottlebrush squirreltail; burning produced grasslands that were slowly reinvaded by big sagebrush (Volland 1976).

Thorough identification of a plant community depends on the identification of its species—an important step in determining its potential for management toward various goals. This is often difficult to accomplish in one visit to a stand because of differences in timing of plant development among species. Dean (1960) presented an account of peak flowering times for species within big sagebrush types that illustrates this point.

12, 13—MOUNTAIN BIG SAGEBRUSH/BUNCHGRASS (fig. 23) AND SUBALPINE BIG SAGEBRUSH/BUNCHGRASS

The mountain big sagebrush subspecies is common in uplands from Oregon to the Rocky Mountains (Beetle 1960, Winward and Tisdale 1977). At higher elevations, mountain big sagebrush is replaced by subalpine big sagebrush, and an unnamed variant of mountain big sagebrush extends from the lower edge of the western juniper zone into the steppe communities in northeastern and central Oregon (Winward 1980). Mountain big sagebrush is found in all Oregon counties east of the Cascade Range, from below Anthony

Figure 23.—Mountain big sagebrush/bunchgrass communities are species rich, have high forage production, and provide dense cover for many wildlife species.

Lakes in Baker County southwest to the Siskiyou Mountains in Josephine County (Beetle 1960, Winward 1980).

Mountain and subalpine subspecies of big sagebrush are moderately tall, flat-topped shrubs (fig. 21B); the flower stalks come from only the upper part of the branches and extend above the foliage (Beetle 1960, Winward and Tisdale 1977). The persistent leaves are wider relative to their length compared with basin big sagebrush, and they are broadest below the leaf lobes (Winward and Tisdale 1977). Alcohol extracts of the leaves of both the mountain and subalpine taxa fluoresce creamish-blue under long-wave ultraviolet light (Winward 1980).

Vegetation

Mountain big sagebrush/bunchgrass stands have a rich diversity of species; 40 plant associates are common (Winward 1980; also see footnote 7, p. 25). Some of the usual associates are the same as those found with other big sagebrush taxa (table 6). Bearded bluebunch wheatgrass, Idaho fescue, needleandthread, giant wildrye, bottlebrush squirreltail, and Sandberg bluegrass are usual dominants in the grass-forb layer. Prairie junegrass and Kentucky bluegrass are more usual with the subalpine form than with mountain big sagebrush. Rabbitbrushes are usually present, and their densities are greater in disturbed stands. California brome, slender wheatgrass, oniongrass, and sedges are common associates of subalpine big sagebrush (Winward 1980).

Mountain big sagebrush and the subalpine form have structurally dense stands (table 7); they have the potential for attaining greater crown cover than the other sagebrush species, subspecies, or form. Crown cover increases after disturbance and as range condition deteriorates (Winward 1980, Winward and Tisdale 1977).

Site

Many upper foothill and mountain sites from 1 070 to 3 050 meters (3,500 to 10,000 ft) in elevation are occupied by mountain big sagebrush (Beetle 1960, Winward 1980, Winward and Tisdale 1977). Schumaker and Hanson (1977) found the mountain form of big sagebrush on sites where annual precipitation varied from 0.5 meter (20 inches) to 1.1 meter (43 inches), slope varied from 6 to 33 percent, and aspects included east through northeast to north. Where both occur in high elevation areas, mountain big sagebrush is found on drier sites, subalpine big sagebrush on moister sites (Winward 1980).

Soil

Mountain big sagebrush occurs on deep, well-drained soils where moisture is available throughout most of the summer (Winward and Tisdale 1977). Schumaker and Hanson (1977) found this subspecies on mixed coarse and fine loamy soils from rhyolite and basalt as well as granite.

Discussion

The greater preference of ruminants for mountain big sagebrush forage may be related to phenological development, nutrient content, or essential oils. Mule deer have shown equal preference for mountain big sagebrush and its unnamed variant,[8] both being more preferred than basin or subalpine big sagebrush.[9] Sheehy (1975) found that mule deer and domestic sheep preferred Wyoming big sagebrush over mountain and basin big sagebrush. Brunner (1972) found that mountain big sagebrush was seldom grazed in Nevada. Growth of mountain big sagebrush is initiated later than that of basin and Wyoming big sagebrushes by about 2 weeks, but seed ripening of the mountain subspecies precedes that of the other two subspecies by about 2 weeks (Winward and Tisdale 1977). Cattle and domestic sheep grazed sagebrush principally in spring and fall according to Garrison et al. (1977), but Pechanec et al. (1965) found that sheep also depended on sagebrush for winter browse. Mountain big sagebrush shows the least variation in chemical content and also has the most persistent leaves among sagebrush taxa (Beetle 1960). The chemical value of different

[8]Personal communication from A. H. Winward, Oregon State University, Corvallis.

[9]Personal communication from D. P. Sheehy, Oregon Department of Fish and Wildlife, Burns.

sagebrushes compares favorably with other forages, although pure diets of sagebrush appear inadequate for maintenance of animals (Beetle 1960, Cook 1972, Dietz and Yeager 1959, Dietz et al. 1962). Consumption of sagebrush foliage may be limited by antimicrobial substances, such as essential oils, but inhibitory effects on the rumen microflora demonstrated in the laboratory (Nagy and Tengerdy 1968) are not likely to be attained in nature because of insufficient rates of release in the acid environment of the rumen (Short et al. 1972). Perhaps the varying consumption of sagebrush forms by grazers, however, is related to differences in consumption and content of essential oils among the sagebrushes (Sheehy 1975).

The dense structure of mountain and subalpine big sagebrush stands and their capacity for increases in plant density and crown cover after disturbance make these communities valuable cover habitats for wildlife. Managers should plan periodic control of parts of some stands to develop openings for mule deer, thus producing more diversity and greater edge length. In fawning and fawn-rearing areas dominated by mountain big sagebrush or subalpine big sagebrush, some dense stands of either form may be best left alone (Winward 1980). The mountain subspecies is readily controlled by flooding (Beetle 1960), as are other forms of big sagebrush (see footnote 8).

Seeding managed stands of mountain big sagebrush with crested or intermediate wheatgrass and seeding stands of subalpine big sagebrush with intermediate wheatgrass, California brome, or smooth brome are usually successful. Seeding, however, is infrequently required because the understory is usually in good condition (Winward 1980). Large populations of gophers in some dense stands of subalpine big sagebrush sufficiently disturb the soil to increase the annual forb component.

14—WYOMING BIG SAGEBRUSH/ BUNCHGRASS (fig. 24)

Wyoming big sagebrush is the most common sagebrush throughout the high desert in Oregon (Winward 1980). It is a low growing shrub, 0.4 to 1 meter (1.5 to 3.3 ft) tall, with an irregular and rounded top (fig. 21A) and with the flower stalks scattered throughout the crown—like small shrubs of basin big sagebrush. The main stem is not trunklike, however, but is comprised of two or three twisted portions at ground level. The persistent leaves are relatively short and wide, more deeply lobed than in other big sagebrush taxa, and their margins curve outward from the base to form bell-shaped blades. Alcohol extracts from the leaves fluoresce shades of brownish-red in long-wave ultraviolet light (Winward 1980, Winward and Tisdale 1977).

Figure 24.—Wyoming big sagebrush/bunchgrass communities occur on relatively dry sites and are the most common of the sagebrush-dominated communities in the Great Basin of southeastern Oregon (Chris Maser photograph).

Vegetation

Many plant species commonly occurring with Wyoming big sagebrush are also found with other taxa, such as basin or mountain big sagebrush. Major associated species include: bearded bluebunch wheatgrass, needleandthread, Thurber needlegrass, bottlebrush squirreltail, Sandberg bluegrass, and cheatgrass. Idaho fescue occurs occasionally with Wyoming big sagebrush (Schumaker and Hanson 1977, Winward 1980). Many stands have a sparse grass-forb layer because of heavy use by livestock and wildlife; some stands and the understory have been altered by natural,

periodic burning (Winward 1980). These disturbances and loss of understory are associated with increased density of sagebrush or other shrubs. There are few perennial forbs, antelope bitterbrush is not a natural component, and cryptogams may fill much of the bare areas in undisturbed stands. The lateral rooting of this subspecies may compete more with herbaceous species than that of other big sagebrush taxa (Winward and Tisdale 1977). A correlation between crown cover or crown diameter and production has been determined for this subspecies (Rittenhouse and Sneva 1977). The stands are not structurally dense (table 7), yet they may totally occupy the site.

Site

Wyoming big sagebrush/bunchgrass is most common at elevations of less than 1 830 meters (6,000 ft) and on more xeric mountain sites than other big sagebrush communities (Winward 1980). Schumaker and Hanson (1977) described stands on northeast aspects of 8-percent slope in an area with 33 centimeters (13 inches) of annual precipitation. The subspecies is common on slopes of major drainages in hot and dry areas from 700 to 1 980 meters (2,500 to 6,500 ft) in Idaho (Winward and Tisdale 1977). In Nevada, this subspecies is found within the terrace sagebrush complex (Brunner 1972).

Soil

Relatively shallow to moderately deep soils are present under stands of Wyoming big sagebrush/bunchgrass; often the soil is slightly calcareous in the surface layer (Winward 1980, Winward and Tisdale 1977). Fine, loamy soils from basalt were associated with the community in Idaho (Schumaker and Hanson 1977); the community is also found on "red-rock surfaces" over deep soils in Nevada (Brunner 1972).

Discussion

Wyoming big sagebrush was of low to intermediate palatability for mule deer and domestic sheep in Oregon compared with six other sagebrush taxa (Sheehy 1975, Winward 1980). Conversely, this subspecies was as palatable as antelope bitterbrush and often severely grazed in parts of Nevada (Brunner 1972). Sparse grass-forb layers are common in Wyoming big sagebrush/bunchgrass stands, and they offer little forage from associated plant species.

Dense, low cover for small animals is offered by some stands of Wyoming big sagebrush. Often, however, the shrubs are too small or scattered to provide much protection, especially not for large mammals and birds. Disturbances of the grass-forb layer causes only moderate increases in density of this subspecies.

15—THREETIP SAGEBRUSH/ BUNCHGRASS (fig. 25)

Threetip sagebrush is distributed in Washington, Idaho, and Oregon (Beetle 1960, Daubenmire 1970). Within Oregon, the species occurs in Baker and northern Harney counties and occasionally in Malheur County (Beetle 1960, Winward 1980; also see footnote 8, p. 36).

Figure 25.—Threetip sagebrush/bunchgrass stand in a usual topographic location. The elevation of this stand, 865 meters (2,837 ft), in northern Malheur County, Oregon, is lower than reported in the literature (see footnote 5, p. 18).

Threetip sagebrush is an erect shrub (fig. 21A) that freely and profusely branches to form a moderately large crown, 0.4-0.8 meter (1.3-2.6 ft) in diameter (Beetle 1960). This species does not normally root from its branches (layering) because of its upright form;

it readily does so when the branches touch the soil, and it sprouts readily from burned crowns (Beetle 1960). Dwarf threetip sagebrush is a low subspecies in some stands, is rarely taller than 0.2 meter (0.7 ft), has a crown from 0.3 to 0.4 meter (1.0 to 1.3 ft) wide, and readily layers from its naturally decumbent branches (Beetle 1960). This subspecies is usually found adjacent to mountain big sagebrush but not mingled with it; dwarf threetip sagebrush occupies shallow soils along ridges rather than the deeper soils at the base of foothills (Beetle 1960).

The leaves of threetip sagebrush are relatively long, 3 centimeters (1.2 inches), and deeply three cleft into linear lobes which may also be divided (Beetle 1960). Alcohol extracts of the persistent leaves fluoresce creamish-blue under long-wave ultraviolet light (Winward 1980).

Vegetation

Many plant species found with big sagebrushes in general, occur with threetip sagebrush in its fescue and wheatgrass communities (Daubenmire 1970, Tisdale et al. 1965, Winward 1980). Plant species composition for the threetip sagebrush/fescue and threetip sagebrush/wheatgrass communities were similar except for the occurrence of fescue. Extensive species included the following: rabbitbrush, big sagebrush, antelope bitterbrush, squaw apple, Sandberg bluegrass, bearded bluebunch wheatgrass, prairie junegrass, needleandthread, Thurber needlegrass, Kentucky bluegrass, threadleaf sedge, arrowleaf balsamroot, dwarf hesperochiron, longleaf phlox, nineleaf biscuitroot, and tapertip hawksbeard.

Canopy cover measurements are high where plants are dense (table 7), since individual crowns are of large diameter, 0.4 to 0.8 meter (1.3 to 2.6 ft), and freely branched (fig. 21A). Threetip sagebrush may form stands sufficiently dense to crowd out herbaceous species (Winward 1980).

Site

Threetip sagebrush/fescue stands occur on moist and cool sites, such as north and east slopes and in depressions, whereas threetip sagebrush/bearded bluebunch wheatgrass stands are found on dry, warm sites where exposure to sun and wind is too severe for fescue; for example, on east slopes curving to the north there are abrupt ecotones between the communities (Daubenmire 1970, Tisdale et al. 1965). In Oregon, this species is reported at elevations of 1 160 meters (3,800 ft) or higher by Winward (1980). Dealy (see footnote 5, p. 18) reports a low elevation of 865 meters (2,837 ft) for this species in northern Malheur County, Oregon. Beetle (1960) reported that threetip sagebrush occurred between 914 and 1 830 meters (3,000 and 6,000 ft).

Soil

Threetip sagebrush is the only resprouting sagebrush species associated with loam to sandy-loam soils in Oregon (Winward 1980). Daubenmire (1970) found stands of the threetip sagebrush/bunchgrass community on Brown, Chestnut, Chernozem, Planosol, and Prairie soils in Washington and Idaho. Threetip sagebrush communities were associated with silty clay loams containing a B horizon at 0.2-0.3 meter (0.7-0.8 ft) and a lime zone below 0.9 meter (2.9 ft) in Idaho (Tisdale et al. 1965). In general, threetip sagebrush communities are associated with deep, well-drained soils (Beetle 1960).

Discussion

Apparently the intensity of browsing of threetip sagebrush varies by subspecies and areas. Winward (1980) considered that grazing by native and domestic animals contributed to the density of present threetip sagebrush/bunchgrass stands. Brunner (1972) observed that threetip sagebrush was never grazed, but he reported that dwarf threetip sagebrush was usually severely grazed.

The structure of threetip sagebrush/bunchgrass stands should provide considerable cover, but the shorter dwarf threetip sagebrush can protect only smaller animals. The resprouting ability and growth form can produce very dense brush fields that vigorously compete with herbaceous species (Winward 1980). Stable shrub densities cannot be maintained with proper grazing or even no use;

periodic thinnings are necessary to attain some management goals. Sandberg and Kentucky bluegrasses are common in threetip sagebrush/bunchgrass stands, and crested wheatgrass can be established on these sites (Winward 1980).

The stone-free mound soils associated with some threetip sagebrush communities provide a favorable substrate for burrowing rodents and badgers (Daubenmire 1970).

16, 17—BOLANDER SILVER SAGEBRUSH/ BUNCHGRASS (fig. 26) AND MOUNTAIN SILVER SAGEBRUSH/BUNCHGRASS (figs. 27 and 28)

Silver sagebrushes are found in seasonally moist areas from central and eastern Oregon eastward across the Rocky Mountains to Nebraska and the Dakotas. Two subspecies are associated with two distinct habitats, closed basins and streamside or pond-edge meadows, that are scattered throughout the Pacific Northwest and intermountain regions (Beetle 1960). The basin subspecies, Bolander silver sagebrush, is distributed within the desert areas of Oregon from Prineville throughout the southeastern third of the State; the streamside-meadow subspecies, mountain silver sagebrush, is most common in east-central and southeastern Oregon where there are seasonally high water tables adjacent to streams and meadows (Dealy 1971, Winward 1980).

These two silver sagebrush subspecies differ morphologically, chemically, and ecologically. Bolander subspecies is a low rounded shrub with erect or spreading dense branches, but mountain silver sagebrush can be taller and more erect (Beetle 1960). Branching of both subspecies creates an irregular crown (fig. 21A). Branches of both subspecies readily form roots when they touch the soil, and the plants resprout from the root crown. The leaves are tapered toward both ends, are usually not lobed, are very silky with white hairs, and smell pungent (like turpentine) when crushed (Beetle 1960). Alcohol extracts of leaves from either subspecies fluoresce creamish-blue shades under long-wave ultraviolet light (Winward 1980). The unlobed leaves and tolerance

Figure 26.—This stand of Bolander silver sagebrush/bunchgrass on an internally drained basin site illustrates the usual bare soil interspaces and sparse understory.

Figure 27.—Mountain silver sagebrush/ bunchgrass stand adjacent to a mountain meadow.

Figure 28.—This detailed view of a mountain silver sagebrush/bunchgrass stand illustrates the usually dense understory.

of soil saturation and seasonal flooding clearly set both silver sagebrushes apart from all other shrubby, tall sagebrushes. Leaves of the other tall species are cleft three or more times, and those shrubs are easily killed by even brief periods of flooding or soil saturation.

Vegetation

Moist sites dominated by silver sagebrushes support rich herbaceous understories in spring, but these understories are usually maintained through the grazing season only in mountain silver sagebrush stands. The sagebrushes are usually the only shrubs present, but muhly, spike rush, rushes, sedges, and a few forb species are associated (Dealy 1971, Winward 1980; also see footnote 7, p. 25). Other plants commonly observed in Bolander silver sagebrush stands include: Douglas sedge, Baltic rush, Newberry cinquefoil, bottlebrush squirreltail, showy downingia, combleaf, tiny mousetail, and cheatgrass (Leckenby and Toweill 1979, Sheehy 1975). Herbaceous species are more abundant in the floristically rich mountain silver sagebrush stands and include some species not present in Bolander silver sagebrush communities, such as: slender wheatgrass, California brome, Nevada bluegrass, sedges, timothy, and Kentucky bluegrass[10] (Winward 1980).

Structural attributes of free branching, layering, and crown sprouting can create considerable cover, but silver sagebrushes are seldom sufficiently tall (table 7) to provide cover for animals larger than swans, geese, rabbits, and coyotes.

Site

Subspecies of silver sagebrush are closely associated with sites that are seasonally very moist to saturated or even temporarily flooded (usually late winter and spring) (Beetle 1960, Cornelius and Talbot 1955, Dealy 1971, Winward 1980; also see footnote 7, p. 25). This single environmental condition eliminates most other plants common to shrub-steppe communities. The internally drained, alkaline basins dominated by Bolander silver sagebrush are frequently ponded to depths of 0.3-0.6 meter (1-2 ft) for at least a month each spring when the snowpack melts. There have been years—1965, for example—when flooding persisted even beyond the tolerance of silver sagebrushes and aerial portions of the shrubs died. The dead branches were replaced within 3 years by new or resprouted individuals, after the basins passed through a structural condition dominated by Newberry cinquefoil and annual forbs (see footnote 7, p. 25). Sites containing the mountain subspecies usually are saturated in spring and early summer, but normally they are covered only briefly with standing water. The exception is found in wet meadows that form ponds (Dealy 1971). Both subspecies occur at midelevation to high elevation: Bolander silver sagebrush, 1 000-1 800 meters (3,500-6,000 ft); mountain silver sagebrush, 1 680-2 240 meters (5,500-8,000 ft) (Beetle 1960, Winward 1980; also see footnote 8, p. 36).

[10]Schallig, W. H. C., unpublished data on file at Oregon State University, Corvallis.

Soil

Silver sagebrush communities are associated with deep soils of variable surface texture (sand to clay) (Beetle 1960, Cornelius and Talbot 1955). Within Oregon, however, these subspecies are dominant on deep clay and alkaline soils (Leckenby and Toweill 1979, Urness 1966, Winward 1980). Clay soils found with mountain silver sagebrush develop wide deep cracks as they dry over the summer, and the flaking surface layers readily slough into deep fissures (Cornelius and Talbot 1955; also see footnote 10).

Discussion

Use of silver sagebrush/bunchgrass stands varies among seasonal ranges. Bolander silver sagebrush foliage is highly preferred by mule deer and domestic sheep (Sheehy 1975; also see footnote 7, p. 25). These basin communities are occupied by mule deer more than expected from their availability on the Silver Lake-Fort Rock winter range (Leckenby 1978a, Urness 1966). On summer range in the same area, Dealy (1971) considered silver sagebrush/muhly stands of low value because they constituted a small area and thus provided limited forage compared with that in adjacent communities. Dealy (1971), however, found that

competition between livestock and deer appeared high for the limited herbaceous forage available. All silver sagebrush communities should be considered important foraging habitats for mule deer, pronghorns, and sage grouse.

Depth and density of vegetation may provide good cover in some mountain silver sagebrush stands, but cover is sparse in the severely grazed alkaline basins dominated by Bolander silver sagebrush. Pronghorns frequently use these "flats" as resting and bedding areas throughout the summer.

The heavy soils and seasonal ponding make forage improvement in most silver sagebrush sites risky at best; introduced species have rarely survived well (Cornelius and Talbot 1955, Leckenby and Toweill 1979, Winward 1980). These communities are best left untilled and unsprayed because of their wildlife value and because the native plants are difficult to replace with other forage species that do as well.

Waterholes are often developed in silver sagebrush basins. Frequently, ditches are dug across the basin floor to drain a shallow pond rapidly into a deep reservoir which maintains a reliable water source longer through the livestock grazing season. The improved drainage produces a shorter period of flooding; new, drier, plant habitats are created that favor big sagebrush and rabbitbrushes over silver sagebrush. In smaller basins, silver sagebrush stands are being slowly replaced by big sagebrush-rabbitbrush communities (Leckenby 1978a). Thus, some trade-offs among multiple resource goals are illustrated in the case of silver sagebrush basins altered for enhancement of water sources for livestock.

18—STIFF SAGEBRUSH/BUNCHGRASS (fig. 29)

Stiff sagebrush (also called scabland sagebrush) communities occur from the Cascade Range and Blue Mountains of Washington through central and southeast Oregon into Idaho (Daubenmire 1970). This short sagebrush species is found regularly at the northern end of the Great Basin within eastern

Figure 29.—The site on which this sparse stand of stiff sagebrush/bunchgrass occurs illustrates the severe conditions under which the species can grow in the Great Basin of southeastern Oregon.

Oregon. It is common in the following Oregon counties: Wasco, Wheeler, Crook, Gilliam, Jefferson, Umatilla, Union, Wallowa, and Harney (Beetle 1960). Winward (1980) found stiff sagebrush stands distributed primarily in northern and northeastern Oregon, but stiff sagebrush was also located from northern Harney County east through Malheur County into Idaho.

Stiff sagebrush is a winter deciduous, low, spreading, and dense shrub (fig. 21C) that consists of short, rigid, decumbent, and brittle branches (Hitchcock et al. 1955, Peck 1961, Winward 1980). Alcohol extracts of the narrow-based and tridentlike lobed leaves fluoresce brownish-red under long-wave ultraviolet light (Winward 1980).

Vegetation

Stiff sagebrush/bunchgrass plant communities are often floristically rich but may appear impoverished because of spacing between plants and sparse ground cover (Daubenmire 1970). Common associated plant species include several mosses (*Tortula, Bryum, Ceratodon, Grimmia*), woodlandstar, biscuitroot, spring draba, autumn willowweed, pink microsteris, dwarf monkeyflower, Sandberg bluegrass, cheatgrass, Pacific fescue, bearded bluebunch wheatgrass, and bottlebrush squirreltail (Culver 1964, Daubenmire

1970, Winward 1980). Hall (1973) found dwarf squirreltail, false agoseris, a biscuitroot, and bighead clover common to stiff sagebrush stands in the Blue Mountains. Other common associated species are listed in table 6.

Although many species provide diversity of forage, the small shrubs and open stands provide little cover for other than the smallest animals (table 8).

Site

Stiff sagebrush in the Great Basin of Oregon is found exclusively on various aspects of rocky scablands that have undulating or rolling relief. Stiff sagebrush/bunchgrass stands are found from 914 to 2 134 meters (3,000 to 7,000 ft) in elevation. They are usually on gentle slopes or benches of 0- to 20-percent slope and occasionally on steeper slopes of up to 40 percent (Beetle 1960, Culver 1964, Hall 1973, Winward 1980).

Soil

Stiff sagebrush communities are associated with very shallow to shallow 10- to 28-centimeter (4- to 11-inch), stony soils that have been developed from basalt and rhyolite (Culver 1964, Daubenmire 1970, Hall 1973, Winward 1980). Soil textures vary from loams to fine clay loams. The profiles usually become saturated with water in winter and spring and are regularly subjected to frost heaving or frost boils.

Discussion

Big game and livestock use stiff sagebrush as browse (Daubenmire 1970, Hall 1973, Winward 1980; also see footnote 7, p. 25). Many commonly associated species are valuable forage for grazing animals.

The low stature and dispersion of stiff sagebrush shrubs does not provide cover of any consequence for animals larger than

Table 8—Structural measurements of short sagebrushes

Sagebrush species	Shrub height		Crown cover[1]	Density			Reference
				Plants	Area		
	Meters	Feet	Percent	Number	Square meters	Square feet	
Stiff	0.2-0.4	0.6-1.3	—	—	—	—	Peck (1961)
	—	—	20	—	—	—	Culver (1964)
	—	—	10-34	—	—	—	Daubenmire (1970)
	—	—	5-20	—	—	—	Hall (1973)
Low	.1-.4	.3-1.3	13-16	55-56	18-58	200	Eckert (1957)
	—	—	26	—	—	—	Culver (1964)
	.1-.2	.4-.5	4-22	1.2-8.3	—	—	Kornet (1978)
	—	—	10.8	.18	—	—	Sheehy (1975)
	—	—	10	—	—	—	Volland (1976)
	.2-.3	.7-.9	6-20	—	—	—	Segura-Bustamante (1970)
	.2	.7	8-26	—	—	—	Dealy (1971)
Black	—	—	11.8	.28	—	—	Sheehy (1975)
	.1-.3	.3-1.0	—	—	—	—	Beetle (1960)
	.1-.4	.3-1.3	—	—	—	—	Hitchcock and Cronquist (1973)
	.3	1.0	—	—	—	—	Brunner (1972)
	.1-.3	.3-1.0	—	—	—	—	Dayton (1931)
Early low	.2	.8	1.5	25	9.29	100	Tisdale et al. (1965)
	.3	1.0	—	—	—	—	Beetle (1960)

[1]Same as crown canopy, canopy closure, or crown density—the proportion of ground surface covered by shrub crowns as vertically projected, like a shadow.

horned larks or ground squirrels. The lack of leaves (this is the only deciduous shrubby sagebrush in the area) in winter severely reduces the little cover this species offers on the scablands during periods of thermal stress. Even in winter, however, the shrubs do provide some protection from erosion by wind (Hall 1973).

Stressful environmental conditions for plant growth, such as waterlogging and consistent frost heaving of very shallow soils, make successful seedings of domestic grasses highly improbable (Hall 1973, Winward 1980). Removal or control of the stiff sagebrush cover would increase thermal stress for small animals, reduce the forage available for both large and small animals, and increase erosion by wind.

19, 20—LOW SAGEBRUSH/BUNCHGRASS (fig. 30) AND CLEFTLEAF SAGEBRUSH/ BUNCHGRASS (figs. 31 and 32)

Low sagebrush/bunchgrass communities typically occur adjacent to or intermixed with big sagebrush communities but are distinctly separate stands of an edaphic (soil-related) climax vegetation associated with shallow, stony soils (Dealy 1971, Dealy and Geist 1978, Franklin and Dyrness 1973). Low sagebrush is common in most counties east of the Cascade Range in Oregon. Beetle (1960) listed the counties where low sagebrush occurs (Baker, Grant, Crook, Jefferson, Wheeler, Harney, Malheur, Lake, Klamath, and Jackson.

Figure 30.—Low sagebrush/bunchgrass communities are common on shallow, stony soils (photo, courtesy Oregon Department of Fish and Wildlife).

Figure 31.—This stand of cleftleaf sagebrush/bunchgrass occurs at 1 524 meters (5,000 ft) in east-central Malheur County, Oregon, adjacent to curlleaf mountainmahogany. This is a new location in Oregon for the subspecies (see footnote 5, p. 18).

Figure 32.—Closeup of a cleftleaf sagebrush/bunchgrass stand illustrating the habit (general appearance) of this subspecies of sagebrush and the gravelly, shallow soil of sites on which it grows in the Great Basin of southeastern Oregon.

Low sagebrush is a gray to green dwarf shrub formed of irregular, short, and stiff branches (fig. 21C). It produces a small crown between 0.4 and 0.8 meter (1.3 and 2.6 ft) wide (Beetle 1960, Brunner 1972). The species infrequently forms roots from branches touching the soil. Both the small, narrow, wedge-shaped, and deeply three-toothed leaves of low sagebrush, as well as the much thinner lobed leaves of the subspecies cleftleaf sagebrush, fluoresce

creamish-blue in alcohol solutions exposed to long-wave ultraviolet light (Winward 1980). A taller variant (as yet unnamed) associated with pumice soils requires more research (Winward 1980.)

Vegetation

Stands vary from small—2 hectares (5 acres)— to wide "flats"1.6 kilometers (1 mi) or more across. The usual associated plants create a rich diversity of species within these stands of vegetation. Common associates are: bearded bluebunch wheatgrass, Idaho fescue, Thurber needlegrass, Sandberg bluegrass, prairie junegrass, one-spike oatgrass, bottlebrush squirreltail, cheatgrass, western needlegrass, woolly eriophyllum, Bloomer fleabane, low pussytoes, yarrow, gay penstemon, Nevada biscuitroot, Holboell rockcress, starved milkvetch, obscure milkvetch, spreading phlox, longleaf phlox, Hooker balsamroot, annual agoseris, daggerpod, granite gilia, bighead clover, and nineleaf biscuitroot (Culver 1964; Dealy 1971; Dean 1960; Eckert 1957, 1958; Hall 1973; Segura-Bustamante 1970; Volland 1976; Winward 1980; also see footnote 7, p. 25).

As with other structurally short sagebrushes, low sagebrush shrubs are too small and too scattered to provide cover for large animals (table 8), but the dense crowns do shelter small animals, such as lizards, snakes, birds, and mice. The evergreen low sagebrush does, however, maintain its minimal cover qualities through winter better than does the deciduous stiff sagebrush.

Site

Low sagebrush/bunchgrass communities are regularly found on dry, relatively sterile, often alkaline sites (Beetle 1960). Although Beetle (1960) reported low sagebrush often occurring on alkaline sites, Brunner (1972), presenting data on the sagebrush genus in Nevada, and Dealy (1971), studying low sagebrush in Oregon, report low sagebrush only on acid to neutral sites. Occurrences are between 914- and 2 743-meter (3,000- and 9,000-ft) elevation. The stands are on most aspects, but commonly they are found on gentle slopes (2-15 percent) in rolling to undulating or flat uplands, top-of-rim edges, level and sloping plateaus, and crests and slopes of ridges (Culver 1964; Dealy 1971; Dean 1960; Eckert 1957, 1958; Hall 1973; Segura-Bustamante 1970; Volland 1976; Winward 1980).

Soil

Low sagebrush thrives on shallow, stony, fine-textured soils derived from basaltic, andesitic, or rhyolitic parent materials. These soils may have basic, neutral, or acidic reactions. They generally are less than 0.6 meter (2 ft) deep, may contain an impermeable (or at least restrictive) clay B horizon, become saturated with water in late winter and spring, and are extremely droughty in summer (Brunner 1972, Culver 1964, Dealy 1971, Dealy and Geist 1978, Eckert 1957, Fosberg and Hironaka 1964, Hall 1973, Segura-Bustamante 1970, Volland 1976, Winward 1980; also see footnote 7, p. 25). Lack of physical support during spring periods of soil saturation can result in damage from trampling (Hall 1973). Extremes of saturation, frost heaving, and drying in these soils make plant survival tenuous at best. Though the species are well adapted, even the low sagebrush and Sandberg bluegrass roots are pedestaled and broken during seasonal cycles of frost heaving and soil drying. Often, cracks in the underlying base rock, or interrupted restrictive layers in the solum produce dispersed soil microsites that are deeper and better drained than surrounding soil. This permits establishment and survival of a few scattered ponderosa pine, western juniper, curlleaf mountainmahogany, antelope bitterbrush, or other shrubs (Dealy and Geist 1978, Segura-Bustamante 1970).

Discussion

Low sagebrush stands are intensively used by wildlife and are particularly important to large ruminants, including livestock. Mule deer regularly and preferentially occupied these communities during mild weather in winter and spring (Leckenby 1978a). Use by pronghorn and sage grouse is also high, though less seasonal. Indigenous species of wildlife intensively graze the associated forbs and grasses. Browsing of low sagebrush by insects, mice, rabbits, hares, sage grouse, and ruminants is also extensive.

Forage species develop as much as 2 weeks earlier in low sagebrush stands than in the adjacent antelope bitterbrush, tall sagebrush, rabbitbrush, western juniper, curlleaf mountainmahogany, or ponderosa pine communities. Grazing animals follow the sequence of forage development which is induced by differences in site factors among these communities. Similar grazing patterns exist elsewhere and appear to be an expression of resource partitioning related to rates of plant growth which in turn are correlated with different plant habitats. In a shortgrass zone, deBoer (1974) found that herds of grazing wildlife preferred plant communities produced by a shallow soil overlying a restrictive hardpan (a soil environment similar to that of short sagebrush stands). Low total herbaceous production and low rates of growth on these sites apparently permitted earlier season grazing that was nonselective for plant species and that maintained growth of vegetative parts that were highly digestible. Two other vegetational zones, both characterized by more precipitation, deeper soils, and lack of a restrictive layer, produced higher rates of plant growth (soil environments similar to those of tall sagebrushes and other steppe communities). There, the grazing animals exhibited marked selectivity of forage species and grazed these stands much later and less intensively than those of the shortgrass zone.

Low sagebrush was one of the most preferred sagebrushes offered to mule deer and domestic sheep (Sheehy 1975). Some subspecies of low sagebrush are grazed more extensively than others by mule deer and other wildlife (Brunner 1972, Dealy 1971, Leckenby 1978a, Volland 1976, Winward 1980). In addition, the plant composition of many stands offers a rich diversity of seasonal forages.

Height, crown cover, and plant density of low sagebrush/bunchgrass stands provide little structure to create hiding or thermal cover for animals larger than ground squirrels, mice, and small birds; these communities are primarily habitats for production of forage. Total crown cover of all vegetation was less where low sagebrush/bunchgrass stands were compared with adjacent big sagebrush communities of similar composition (Segura-Bustamante 1970): western juniper/antelope bitterbrush-big sagebrush, 39-percent total cover; western juniper/antelope bitterbrush-low sagebrush, 38 percent; antelope bitterbrush-big sagebrush, 36 percent; antelope bitterbrush-low sagebrush, 34 percent; big sagebrush, 35 percent; and low sagebrush, 23 percent. Crown cover of western juniper, however, was similar among stands dominated by either sagebrush. Abundance of forbs increased steadily, whereas total crown cover decreased in those stands. Densities of bearded bluebunch wheatgrass, Thurber needlegrass, Sandberg bluegrass, and Idaho fescue were greater where these grasses occurred with low sagebrush compared with big sagebrush/bunchgrass stands (Segura-Bustamante 1970).

Management designed to harvest or improve production of forage from low sagebrush/bunchgrass stands should be planned after careful evaluation of the goals, trade-offs, and risks. These sites are fragile, generally will not produce much more forage after treatment, are not suitable for cultivation, and occur on soils that are too shallow for crested wheatgrass or other readily available introduced species (Dealy 1971, Hall 1973, Volland 1976, Winward 1980). Abundance of remnant forbs and grasses may improve with changes in grazing management (Dealy 1971, Winward 1980), but some stands in poor condition have apparently not changed even where they were completely protected for 30 years or more.

Identification of specific low sagebrush plant communities requires data from more than one season (Leckenby 1978a). Dean (1960) described plant species appearance (especially phenology of flowering) in spring, summer, and autumn. The marked differences in time of plant species appearance, recognition, or prominence in the physiognomy (outward feature) of a stand produce quite different impressions of low sagebrush communities. In spring when obscure milkvetch is prominently flowering, the foliage easily contrasts with the wet soils; in summer when the colorful ashy penstemon is in full bloom, the obscure milkvetch has all but disappeared.

21—BLACK SAGEBRUSH/BUNCHGRASS

Black sagebrush is more common in that portion of the Great Basin east of Oregon (Hitchcock et al. 1955), but Beetle (1960) reported it scattered in Oregon's Harney and Lake Counties. Winward (1980) found that the relatively few areas of this sagebrush occurred primarily in the southern portions of Malheur, Harney, and Lake Counties. West et al. (1978) observed black sagebrush in many stands throughout Nevada and in Utah.

The shrub is low to dwarf (fig. 21C); its branches are decumbent; the flower stalks are brown and persistent (Beetle 1960). Although some authors consider black sagebrush a variety of low sagebrush (Hitchcock and Cronquist 1973), there are important differences (Winward 1980). There may be subspecies of black sagebrush that are also important to recognize, for at least a glossy-green form appears to be grazed less than a gray-green form (Brunner 1972). Beetle (1960) also described these color phases. The broadly wedge-shaped (flabelliform), three- to five-lobed leaves produce alcohol solutions that fluoresce brownish-red during exposure to long-wave ultraviolet light (Winward 1980).

Vegetation

Plant species associated with black sagebrush communities are often the same as those found with stiff and low sagebrush communities. Species lists from black sagebrush/bunchgrass stands regularly include one or more of the following: bearded bluebunch wheatgrass, Indian ricegrass, bottlebrush squirreltail, and Sandberg bluegrass; occasionally, needleandthread may be present (Winward 1980).

Short stature and wide spacing of shrubs throughout the stands create sufficient cover for hiding or thermally protecting only the smallest animals (table 8).

Site

Vegetation stands of black sagebrush/bunchgrass occur between 1 200 and 2 740 meters (4,000 and 9,000 ft) on drier, shallow sites (Beetle 1960, Dayton 1931, Winward 1980). The species is common to level plains and slopes in foothills and mountains and is reported to occur with ponderosa pine, aspen, and woodland types—even into the spruce-fir zone (Dayton 1931).

Soil

The black sagebrush/bunchgrass community, like other short sagebrushes, is associated with shallow, stony soils (Beetle 1960). This species, however, has particular affinity for calcareous soils (Brunner 1972, Winward 1980). Either lime hardpans or a concentration of lime is present in most soils supporting this sagebrush species. Such a relationship contrasts with that of the neutral to acid volcanic soils common to low sagebrush stands (Brunner 1972, Dealy 1971).

Discussion

Six other sagebrush species were more palatable than was black sagebrush to mule deer and domestic sheep (Sheehy 1975). Pronghorns (Winward 1980), domestic sheep, and domestic goats (Dayton 1931) were reported to intensively graze black sagebrush. Use may depend on the variety, form, or subspecies present (Brunner 1972). Cultural treatment and seeding of forage or cover plants are not likely to improve composition and structural qualities of black sagebrush stands. Disturbance of these stands initiates long succession from Sandberg bluegrass dominance back to other bunchgrasses. Often, stands in poor condition have not recovered although they were protected from grazing (Winward 1980).

22—EARLY LOW SAGEBRUSH/BUNCHGRASS

Early low sagebrush has also been called alkali sagebrush (Beetle 1960, Tisdale et al. 1969) and early sagebrush (Winward 1980). This species is also found primarily east of Oregon, but limited local stands exist in Deschutes, Crook, Lake, and Harney Counties (Beetle 1960, Brunner 1972, Tisdale et al. 1965, Winward 1980). Eckert (1957) reported a large-headed form of low sagebrush that flowered

from mid-July until mid-August in northern Lake and Harney Counties; the phenology of the form he observed matches that of this uniquely early-flowering species of short sagebrush.

The form and stature of early low sagebrush and the sites it is common to in many ways resemble those of low sagebrush. It is a dwarf shrub (fig. 21C) with lax and spreading branches that frequently layer (Beetle 1960). These two short sagebrushes, early low and low, form adjacent pure stands; but they may also occur mixed together (Eckert 1957, Winward 1980). These species cannot be readily separated on the basis of leaf form or fluorescence. Alcohol extract solutions fluoresce creamish-blue from exposure to long-wave ultraviolet light (Winward 1980). Difference in phenology is the most suitable diagnostic characteristic to separate early low and low sagebrush (see footnote 8, p 36).

Vegetation

Plants associated with early low sagebrush are commonly found in stands of other short sagebrushes. Typical lists include pussytoes, wild buckwheat, phlox, violet, Idaho fescue, Thurber needlegrass, Sandberg bluegrass, and bottlebrush squirreltail (Tisdale et al. 1965).

Early low sagebrush stands offer little structural cover because of plant density (table 8). Stands rich in species may serve as valuable forage areas, but only small animals find much shelter in typical stands.

Site

Early low sagebrush stands are found at elevations from 1 830 to 2 440 meters (6,000 to 8,000 ft) on poorly drained, hot, and dry sites; the ecological situation is similar to sites dominated by low sagebrush (Beetle 1960, Winward 1980.)

Soil

Brunner (1972) found early low sagebrush in pure stands on shallow stony soils, but the species also occurred in mixed stands with other sagebrushes on deeper soils. The name "alkali sagebrush" came from plants found on fine textured and highly alkaline soils (Beetle 1960). In Idaho, Tisdale et al. (1965) associated this species with a silty clay loam subsoil at 0.1 meter (0.3 ft) and a strongly developed B horizon at 0.3-0.4 meter (1-2 ft).

Discussion

Early low sagebrush, except for its earlier flowering, may be best considered a form of low sagebrush (Winward 1980). Its preference as forage by mule deer has not been evaluated. This species was not grazed in Nevada and was seldom eaten by sage grouse (Brunner 1972). Management of early low sagebrush stands should enhance or preserve the diversity of native forage species and adjust the grazing season to accomplish that goal. Crested wheatgrass is not adapted to the sites because of the shallow, heavy, and seasonally saturated soils.

Other Communities Dominated by Shrubs

23—SQUAW APPLE/BUNCHGRASS (fig. 33)

Squaw apple is an intricately and rigidly branched, deciduous shrub that may attain heights of 2 meters (6.5 ft) (Hitchcock and Cronquist 1973). Subspecies or varieties have not been identified.

Figure 33.—Squaw apple/bunchgrass community illustrating the large, robust form of the species and other species that commonly occur with it, such as mountain big sagebrush and bearded bluebunch wheatgrass (Chris Maser photograph).

Vegetation

Although squaw apple is seldom the dominant (measured by canopy cover) shrub of broad expanses, it may occasionally assume dominance in some stands. Squaw apple constitutes the tallest shrub layer except where antelope bitterbrush is present. A variety of other shrub species comprise the shorter shrub layer. Squaw apple also occurs in eastern Oregon in association with scattered ponderosa pine and western juniper.

Squaw apple communities may have as many as four major strata, the tallest at a height of 1.5 meters (5 ft). Mountain big sagebrush may average 0.8 meter (2.5 ft) and is usually the dominant shrub of the middle shrub layer with green and gray rabbitbrush occasionally present. The subshrub granite gilia and the shrublike slenderbush eriogonum comprise a sparse, low shrub layer 0.5 meter (1.5 ft) tall. The herbaceous layer averages 0.2 meter (0.5 ft) tall and consists primarily of wild buckwheat, fleabane, rockcress, low pussytoes, Thurber needlegrass, bearded bluebunch wheatgrass, Sandberg bluegrass, and cheatgrass.

Communities are characterized by a shrub cover of approximately 10-15 percent.

Often two to five squaw apple bushes may be found growing close together so that their branches intertwine, giving the illusion of one huge shrub, 2.0-2.5 meters (6.5-8 ft) in diameter.

Threetip sagebrush, averaging 0.6 meter (2 ft) tall, occasionally dominates the intermediate shrub layer. Also included in this layer are a few scattered big sagebrush, gray rabbitbrush, and green rabbitbrush. Threetip sagebrush and the rabbitbrushes are rounded shrubs that branch from near the base. The basal leaves of wild buckwheat and low pussytoes may form small islandlike mats on the otherwise stony and bare surface.

Site

The range of squaw apple is restricted to high, moist hillsides in the northern portion of southeastern Oregon. The topography is generally characterized by rolling hills and prominent drainages.

Soil

Squaw apple commonly occurs on moderately deep, well-drained soils. Texture generally varies from loam to sandy loam. The percent of soil surface covered by cobbles and stones and cobble and stone volume in the soil profile are highly variable.

Squaw apple also occurs on very shallow, medium-textured soils derived from weakly consolidated, occasionally fractured tuff and diatomaceous deposits. Plant density is likely controlled, in part, by fracturing frequency of the soil parent material. Plant crowns act as a protective influence on these highly erodible soils.[11]

Discussion

Hayes and Garrison (1960) described squaw apple as fair browse for domestic sheep and cattle in spring and for deer in the winter. Beneath the canopy of squaw apple is a well-concealed haven for small animals. Stem density is high in the interior of squaw apple crowns, providing small birds excellent protection from predators.

24—BLACK GREASEWOOD/GRASS (fig. 34)

Black greasewood is a spiny, freely branched shrub that may grow nearly 2.5 meters (8 ft) high (Hitchcock and Cronquist 1973). The succulent leaves of this deciduous species give a luxuriant appearance to the plant (Shantz and Piemeisel 1940). The bright yellow green of communities dominated by black greasewood contrasts with the gray green of sagebrush communities during the summer. The species is not relished by livestock, but severe grazing may produce smaller plants with compact canopies. Black greasewood will resprout from the root crown after fire (Daubenmire 1970).

[11]J. Michael Geist, unpublished data on file at Range and Wildlife Habitat Laboratory, La Grande, Oregon

Figure 34.—The black greasewood/grass community is one of the tallest of the shrub types and provides excellent protective cover for nesting birds and small mammals and thermal cover for all species.

Vegetation

Generally, black greasewood communities have shrub and herbaceous layers, but community structure varies, depending on species composition or age class.

Some black greasewood areas contain few other shrubs, and in pure stands the plants are widely spaced with large interspaces of bare soil (Shantz and Piemeisel 1940). On some sites with almost pure stands, the shrub cover ranges from 10 to 20 percent and averages between 0.9 meter and 1.2 meters (3 and 4 ft) tall. The interspaces are mainly barren but are occasionally occupied by cheatgrass and bottlebrush squirreltail. Russianthistle is present but restricted to disturbed areas near roads.

Black greasewood comprises 90-95 percent of the shrubs in stands of the valley bottoms; the remainder consists of very large shadscale saltbush plants (reaching heights of 1 meter—3.28 ft), green rabbitbrush, and basin big sagebrush. Cheatgrass, which usually dominates the herbaceous layer, is confined beneath shrub canopies.

Patches of the strongly rhizomatous desert saltgrass occur in areas of greater moisture. Desert saltgrass swards occur in some dense black greasewood communities where the shrub cover may reach almost 30 percent. Black greasewood dominates the shrub layer, both in percent composition and height—1.3 meters (4.3 ft). Big sagebrush and green rabbitbrush also occur. In some communities, giant wildrye attains the greatest height of any species but is present only in small amounts; however, this grass may have been more prevalent before grazing. A layer of cheatgrass is common between and beneath the shrubs, and the amount of bare ground varies according to fluctuations in the density of this species.

Site

The black greasewood/grass community reaches its best development on lowlands in the Great Basin of southeastern Oregon, occurring primarily on saline-sodic flood plains, playas, and terraces. On middle slopes of about 10 percent, spiny hopsage, as well as giant wildrye and green rabbitbrush, is conspicuous in the black greasewood community. On the lower slopes, spiny hopsage and shadscale saltbush become prominent. The low growing bud sagebrush occurs sparingly, and cheatgrass dominates the herbaceous layer.

Soil

The black greasewood/grass community generally occurs on soils exhibiting high alkalinity and high water tables (Potter 1957); however, Shantz and Piemeisel (1940) reported alkali is not necessary for the presence of black greasewood, but a high moisture content of the soil is.

Discussion

The black greasewood/grass community provides thermal cover for all species of wildlife and excellent protective cover for nesting birds and small mammals. This excellent cover is primarily due to the tall growth form of black greasewood combined with its spines and coarse structure.

Rickard (1964) reported sagebrush was replaced by black greasewood in an area that had been excessively grazed. The attendant loss of a relatively nonsaline surface layer produced a saline-sodic environment where water was available only to the halophytic black greasewood. This indicates the limited options

available for management of stands that occur on marginal sites.

25—SHADSCALE SALTBUSH/ BUNCHGRASS (fig. 35)

Vegetation

Shadscale saltbush/bunchgrass is the dominant community on large expanses of the high desert in southeastern Oregon (see footnote 5, p. 18). Crown cover in most stands averages 15 percent and ranges from 10 to 35 percent. Heights average 37 centimeters (15 inches) and range from 30 to 45 centimeters (12 to 18 inches). Spiny hopsage is a common species, generally with a crown cover of less than 5 percent; height averages 62 centimeters (24 inches) and ranges from 50 to 70 centimeters (20 to 28 inches) between sites. Big sagebrush is a sparse component in most areas, with an average crown cover of less than 5 percent and an average height of 56 centimeters (22 inches), ranging from 50 to 70 centimeters (20 to 28 inches). Big sagebrush generally appears as small patches within the type, indicating a possible variation in soil. Bud sagebrush is common on most sites, with a crown cover averaging less than 5 percent but ranging up to 10 percent in some areas; average height is 15 centimeters (6 inches), ranging from 10 to 20 centimeters (4 to 8 inches). The only other shrubs commonly present are gray and green rabbitbrushes, normally with less than 1-percent crown cover. Heights of gray and green rabbitbrushes average 48 and 30 centimeters (19 and 12 inches), respectively.

Figure 35.—Shadscale saltbush/bunchgrass community occurs on large expanses of the high deserts (Chris Maser photograph).

Average height of the grass-forb layer in this community is 14 centimeters (6 inches), ranging from 5 to 25 centimeters (2 to 10 inches). In most cases, total crown cover for the forb component is less than 1 percent (see footnote 5, p. 18). Dominance of the herbaceous layer varies between Sandberg bluegrass and bottlebrush squirreltail; average crown cover of each species is generally less than 5 percent. Sandberg bluegrass occurs in shrub interspaces and under shrub crowns; bottlebrush squirreltail, however, is found primarily under shrubs. The average height of Sandberg bluegrass, including seedstalks, is 10 centimeters (4 inches); that of bottlebrush squirreltail, 15 centimeters (6 inches). Cheatgrass, the only other grass present, has an average crown cover of less than 1 percent.

Forbs are sparse in this type. Only clasping pepperweed and Russianthistle are common. Crown cover is generally less than 5 percent and rarely exceeds 15 percent. Rare species are halogeton, wild buckwheat, and milkvetch.

Site

Most stands of this community occur on relatively level, lowland sites, but some are present on rolling topography. Slope varies from 0 to 30 percent among sites, directional aspect from north-northwest to south; the community is found on all slope positions. Macrorelief is level to moderately rolling hills, and microrelief is moderately smooth to moderately rough (see footnote 5, p. 18).

Soil

Soils are moderately deep, varying from silt loams to coarse gravelly and stony silt loams. Cobble and stone cover of the soil surface varies from 5 to 40 percent, with erosion pavement made up of coarse gravels that occupy small, low areas in shrub interspaces. In some lowland flats, dry soil surfaces in depression spots exhibit cracked and plated, polygonal patterns. Soil in all areas is strongly alkaline. In most areas, edges and bottoms of surface stone are encrusted with a thin calcareous layer (see footnote 5, p. 18).

Discussion

Vegetation in all stands appears to have had a long period of heavy use by livestock. Most perennial bunchgrass plants are present only under the protection of shrub crowns. The most common forbs are annual species (Russianthistle and clasping pepperweed) on abused ranges. Rodent burrows, mostly of kangaroo rats, are present in most sites but concentrated in areas of rolling, hilly relief. Mounds in these areas are large, 2 to 5 meters (7 to 16 ft) in diameter, and occur on ridges and slopes at a density up to 25 per hectare (10 per acre). Fewer and smaller mounds are found in bottoms and on flat topography. Small mounds of burrowing rodents are present on level areas with a density up to 12 per hectare (5 per acre). Large mounds vary from 4.5 to 6 meters (15 to 20 ft) in diameter and occur on flats at a density of approximately 10 per hectare (4 per acre).

The primary dispersal pattern of halogeton into the shadscale saltbush type in the Great Basin of Oregon is from highway shoulders and barrow pits to rodent mounds and other disturbed areas. From a survey of two 300-meter (985-ft) by 10-meter (33-ft) transects, beginning 10 meters from a highway shoulder and moving at a right angle to the road, only 2 halogeton plants were discovered in vegetation undisturbed by rodents, and 12 plants or small groups of plants were counted on rodent mounds. Frequency of halogeton fell off with distance from the highway.

Holmgren and Hutchings (1972) described shadscale saltbush as being palatable to livestock, but because of its spiny stems, use was limited to 15 to 20 percent of the previous season's growth. Bud sagebrush was generally palatable only in late winter, but it may be consumed all winter on occasion. It is considered more palatable for domestic sheep than for cattle. Russianthistle and cheatgrass are often abundant on heavily grazed shadscale saltbush ranges. These species are considered both palatable and nutritious by Holmgren and Hutchings (1972) but are undependable sources of forage because they are annuals.

Grassland Communities

The following natural communities dominated by grass and grasslike plants include seasonally wet and wet meadows, as well as subalpine grasslands. Shrubs and trees are either minor components or are absent from these communities.

26—SEASONALLY WET MEADOWS (figs. 36 and 37)

Vegetation

At low elevations, seasonally wet meadow vegetation is comprised primarily of grasses and sedges. Shrubs, such as willow, may occur in riparian situations adjacent to the type, or dry site shrubs may be present in stands on high ground or upslope at the dry edge of the type. Grasses include Kentucky bluegrass, Sandberg bluegrass, skyline bluegrass, Wheeler bluegrass, northern meadow barley, and spike trisetum. Sedges that may be present are smallwing, epapillous, Douglas, Liddon, slenderbeak, and Raynolds. Rushes generally occur as minor species; the most common in southeastern Oregon may be Drummond and swordleaf (Hansen 1956).

Hansen (1956) described shrubs in subalpine seasonally wet meadows on Steens Mountain as low weatherbeaten forms typical of windswept high mountain vegetation. Common shrubs (willows listed in appendix under "TREES") are Drummond willow, coyote willow, snow willow, bush cinquefoil, carthamoid goldenweed, and dwarf blueberry. Only four grass and grasslike species were reported—false-scirpus sedge, subnigricans sedge, winter bentgrass, and spreading woodrush. Forbs were more abundant: crag aster, elkslip marshmarigold, alpine shootingstar, Sierra willowweed, Watson willowweed, white bogorchid, oblongleaf bluebells, Rocky Mountain parnassia, lousewort, American bistort, Kellogg's knotweed, short-leaved cinquefoil, plainleaf buttercup, modest buttercup, roseroot stonecrop, and crisped starwort.

Figure 36.—Extensive seasonally wet meadows are shown with lesser amounts of permanently wet meadows along streams and around ponds.

Figure 37.—Seasonally ponded sumps at the western edge of the Great Basin generally dry up by mid-season. These areas are severely limited in production of forage.

Site

Seasonally wet meadows can occur in any vegetation zone in the high desert, from bottomlands of low elevation to subalpine ranges. Communities are present as either seasonally ponded or wet swales with no external drainage or as transitional stands between wet meadows and dryland shrub types (Dealy 1971). Where streams have been channeled because of erosion, wet meadows often have been permanently converted to either seasonally wet meadows or dryland shrub communities. In high precipitation zones or on sites where a subsurface lateral drainage emerges at valley edges (toe slopes), the seasonally wet grassland community often becomes prominent. Seasonal seeps, springs, and streams in any slope position often provide small stands of the community.

Soil

Seasonally wet meadows generally occur on moderately deep to deep clay or clay loam soils. Soils under meadows in good condition are high in organic matter and moisture-holding capacity. Wide cracks occur in the dry clay soils, producing a churning action (surface soil falls into cracks when the soil is dry and is incorporated at a lower level when soils become wet and cracks close) which mixes the upper horizons. Trampling of meadows by livestock during wet periods can result in soil damage and thus damage forage plants.

Discussion

Seasonally wet meadows are highly attractive to domestic and wild ungulates, and heavy grazing for more than 100 years has depleted vegetation of these stands. Sites large enough to provide substantial forage may be practical for intensive management of livestock. Small sites, however, such as near seasonal seeps and springs, may be best developed for wildlife but with water piped outside the protected habitat. Young tender forbs and grasses available into late spring contribute to optimum habitat for young grouse (Bump et al. 1947) and probably other gallinaceous birds. An oasis such as this is used by many wildlife species for food and cover.

27—PERMANENTLY WET MEADOWS (fig. 38)

Vegetation

Plant species composition of stands varies considerably among permanently wet sites on rangelands of the high desert. Grasses and sedges are typically dominant in meadows in good condition, and the forbs may also be abundant. At elevations below the subalpine zone, Hansen (1956) stated that whiplash willow was the most abundant shrub in meadows. Common grass and grasslike species were creeping bentgrass, northern meadow barley, mountain hairgrass, and ovalhead sedge. Columbia monkshood, primrose monkeyflower, and Scouler St. Johnswort were the most common forbs.

Figure 38.—Small areas of permanently wet meadows around seeps and springs are typical of the high desert mountains.

Site

Other than the large meadowlands on private holdings, wet meadow communities are found primarily as belts adjacent to riparian zones and as patches around perennial springs and seeps. They can be found on any aspect and most slopes, but those around springs and seeps may be more common on northerly aspects.

Discussion

Heavy grazing of most wet meadows for over 100 years has had a marked effect on the composition and productivity of these communities. Through recently developed manage-

ment practices, some riparian zones and adjacent wet meadows are being improved.[12] Small areas of meadow around springs and seeps within expanses of drier range may appear to be uneconomical for management planning, yet they are stands where livestock and wildlife concentrate. Because of their special values for wildlife, it may be desirable to protect them to enhance the production of grasses, forbs, and shrubs and thus improve cover and forage for a wide variety of small animals and birds.

28—SUBALPINE BUNCHGRASS (figs. 39 and 40)

Vegetation

Grassland communities of the subalpine zone are characterized by a dominant stand of fescue, primarily sheep fescue (Maser and Strickler 1978). Other grasses and grasslike species are rough fescue, prairie junegrass, Cusick bluegrass, longtongue mutton bluegrass, Sandberg bluegrass, and Dunhead sedge (Hansen 1956). Areas with disturbed soil contain small amounts of forbs (Hansen 1956).

Site

Hansen (1956) found the subalpine zone above 2 439-meter (8,000-ft) elevation predominantly grassland interspersed with large areas of bare windswept ground and the lower 244 meters (800 ft) overgrown to short sagebrush.

Discussion

Communities in subalpine regions are fragile and can be severely damaged by livestock grazing and trampling. High winds and unstable soils combined with severe grazing can produce rapid erosion of the surface layer of grassland soils. Large, bare windswept areas are probably a product of severe use by domestic sheep during the late 1800's and early 1900's. Griffiths (1902) toured through southeastern Oregon and referred to domestic sheep use as extremely heavy. Vegetation was severely damaged. Griffiths (1902) noted large clouds of dust caused by bands of domestic sheep during the peak of the grazing season. Mule deer, pronghorns, bighorn sheep, and occasionally Rocky Mountain elk also use these high elevation areas.

[12]Personal communication, 1979, from Robert Kindschy, Bureau of Land Management, Vale, Oregon.

Figure 39.—Subalpine grassland of the high desert mountains; sheep fescue dominates the site (Chris Maser photograph).

Figure 40.—Detailed view of a subalpine grassland; sheep fescue dominates the site (Chris Maser photograph).

Successional Vegetation

Successional patterns are highly complex in the communities of the northern Great Basin. Current composition of plant species can be misleading when site potential and suitable management alternatives are determined for various stands. Because of alterations by natural fire patterns and a long

history of heavy use by livestock, there are relatively few communities or local stands in the desert rangelands that can be considered at or near climax condition. In other words, few stands are in a natural balance with the environment. The stands most difficult to identify are those that have been most severely altered.

Much work has been done to identify subspecies of big sagebrush (Beetle 1960, Beetle and Young 1965, Winward 1970, Winward and Tisdale 1977). Some of this work includes identification of typical soils and sites on which various subspecies are found. For example, Winward and Tisdale (1977), besides giving a taxonomic description of the subspecies, describe basin big sagebrush as growing "in deep, well drained soils of valley bottoms and lower foothill regions." They describe the occurrence of the subspecies in terms of elevation and response to disturbance. Recognition of subspecies and information on sites, along with soils and identification of remnant species that are characteristic of climax or advanced successional communities, can often help managers determine potential for a community.

The relationship between dominance of sagebrush and that of bunchgrass in climax shrub steppe communities is not understood. An excellent stand of grass dominated by bearded bluebunch wheatgrass or Idaho fescue and bearded bluebunch wheatgrass, either devoid of big sagebrush or having a small component of this shrub, may appear on the surface as a climax grassland community. That premise is usually not the case in the shrub steppe. Central and southeastern Oregon steppe communities devoid of a major shrub component are uncommon, and those that do appear as grasslands may have resulted from burning (Franklin and Dyrness 1973).

A brief examination of sites in question should help observers to correctly classify the stands. If topography, elevation, and soils in areas of question are similar to adjacent types with stands of shrubland communities, there is a greater than 90-percent chance that the questionable type is a shrub-grass climax in some stage of succession. Nearly complete destruction of the grass-forb layer under a shrub or tree-shrub-dominated stand can also make identification of plant communities difficult. Here, discovery of remnants of grass species and an analysis of site factors can help identify the original plant community.

An important key to developing a management outlook is recognizing ecological potential of the site—the potential of a community to support vegetation of interest. For example, Burkhardt and Tisdale (1969) presented strong evidence that with management and fire control in southwestern Idaho, western juniper has the potential to occupy the entire mountain big sagebrush/bunchgrass community. Given a site with this potential, a seed source, and barring fire or other repression of the trees and shrubs, the inevitable conclusion will be a western juniper/big sagebrush/bunchgrass stand. Similarly, given a potential sagebrush/bunchgrass community in a bunchgrass successional stage, the inevitable conclusion, barring inhibition of developing sagebrush, will be a shrub/grass community. With such knowledge built into management plans, managers will be spared the frustration of seeing "invasions" of shrubs or trees into communities considered stable "grass" types or "shrub/grass" types. The managers can then plan management strategies of stocking rates, season of use, manipulation of vegetation, and "preserved diversity" to suit established priorities based on the ecological realities of each site's potential.

The rate of successional advancement can vary greatly within any community. Experienced managers generally recognize and have a feel for this. A light fire that leaves scattered shrubs in a sagebrush type provides a ready seed source for reoccupancy by shrubs. A hot extensive fire, on the other hand, may virtually eliminate seed sources of shrubs over a great distance. Burning a south exposure shrub/grass community can produce microclimate conditions that may prevent reestablishment of shrubs for a long time. Such effects can be assessed and the information used in projecting future management alternatives.

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Appendix

Common and Scientific Names of Animals

Common name	Scientific name	Symbol[1]
	MAMMALS	
Badger	*Taxidea taxus*	
Beaver	*Castor canadensis*	
Bighorn sheep	*Ovis canadensis*	
Black-tailed jackrabbit	*Lepus californicus*	
Bushy-tailed woodrat	*Neotoma cinerea*	
Cattle	*Bos taurus*	
Coyote	*Canis latrans*	
Deer	*Odocoileus* sp.	
Domestic sheep	*Ovis aries*	
Domestic goat	*Capra* sp.	
Gophers	*Thomomys* sp.	
Ground squirrel	*Spermophilus* sp.	
Hare	*Lepus* sp.	
Kangaroo rat	*Dipodomys* sp.	
Mule deer	*Odocoileus hemionus*	
Pronghorn	*Antilocapra americana*	
Rabbit	*Sylvilagus* sp.	
Rocky Mountain elk	*Cervus elaphus*	
Vole	*Lagurus* sp.	
	BIRDS	
Geese	*Branta* sp.	
Horned lark	*Eremophila alpestris*	
Lark sparrow	*Chondestes grammacus strigatus*	
Sage grouse	*Centrocercus urophasianus*	
Sage sparrow	*Amphispiza belli*	
Swan	*Olor* sp.	

Common and Scientific Names and Symbols of Plants

	TREES	
Bittercherry	*Prunus emarginata*	PREM
Chokecherry	*Prunus virginiana*	PRVI
Cottonwood	*Populus* sp.	POPUL
Drummond willow	*Salix drummondiana*	SADR
Fir	*Abies* sp.	ABIES
Juniper	*Juniperus* sp.	JUNIP
Ponderosa pine	*Pinus ponderosa*	PIPO
Quaking aspen	*Populus tremuloides*	POTR
Spruce	*Picea* sp.	PICEA
Western juniper	*Juniperus occidentalis*	JUOC
White fir	*Abies concolor*	ABCO

[1]After Garrison et al. (1976).

Appendix (continued)

Common name	Scientific name	Symbol[1]
	SHRUBS	
Antelope bitterbrush	*Purshia tridentata*	PUTR
Basin big sagebrush	*Artemisia tridentata* subsp. *tridentata*	ARTRT
Big sagebrush	*Artemisia tridentata*	ARTR
Black greasewood	*Sarcobatus vermiculatus*	SAVE2
Black sagebrush	*Artemisia nova*	ARNO2
Bolander silver sagebrush	*Artemisia cana* subsp. *bolanderi*	ARCAB
Broom snakeweed	*Gutierrezia sarothrae*	GUSA
Bud sagebrush	*Artemisia spinescens*	ARSP
Bush cinquefoil	*Potentilla fruticosa*	POFR
Carthamoid goldenweed	*Haplopappus carthamoides*	HACA
Cleftleaf sagebrush	*Artemisia arbuscula* subsp. *thermopola*	ARART
Coyote willow	*Salix exigua*	SAEX
Creeping Oregon grape	*Berberis repens*	BERE
Curlleaf mountainmahogany	*Cercocarpus ledifolius* var. *ledifolius*	CELEL
Desert rockspirea	*Holodiscus dumosus*	HODU
Dwarf blueberry	*Vaccinium caespitosum*	VACA
Dwarf threetip sagebrush	*Artemisia tripartita* subsp. *rupicola*	ARTRR
Early low sagebrush	*Artemisia longiloba*	ARLO2
Goldenweed	*Haplopappus* sp.	HAPLO2
Granite gilia	*Leptodactylon pungens*	LEPU
Gray horsebrush	*Tetradymia canescens*	TECA
Gray rabbitbrush	*Chrysothamnus nauseosus*	CHNA
Green rabbitbrush	*Chrysothamnus viscidiflorus*	CHVI
Hopsage	*Grayia* sp.	GRAYI
Horsebrush	*Tetradymia sp.*	TETRA
Low sagebrush	*Artemisia arbuscula* subsp. *arbuscula*	ARARA
Mountain big sagebrush	*Artemisia tridentata* subsp. *vaseyana*	ARTRV
Mountain silver sagebrush	*Artemisia cana* subsp. *viscidula*	ARCAV
Mountain snowberry	*Symphoriocarpus oreophilus*	SYOR
Rabbitbrush	*Chrysothamnus* sp.	CHRYS3
Sagebrush	*Artemisia* sp.	ARTEM
Saskatoon serviceberry	*Amelanchier alnifolia*	AMAL
Shadscale saltbush	*Atriplex confertifolia*	ATCO
Silver sagebrush	*Artemisia cana*	ARCA
Snow willow	*Salix nivalis*	SANI
Spiny hopsage	*Grayia spinosa*	GRSP
Squaw apple	*Peraphyllum ramosissimum*	PERA3
Stiff sagebrush	*Artemisia rigida*	ARRI
Subalpine big sagebrush	*Artemisia tridentata* form *spiciformis*	ARTRS
Threetip sagebrush	*Artemisia tripartita*	ARTR2
Wax currant	*Ribes cereum*	RICE
Whiplash willow	*Salix caudata*	SACA
Willow	*Salix* sp.	SALIX
Wyoming big sagebrush	*Artemisia tridentata* subsp. *wyomingensis*	ARTRW

[1]After Garrison et al. (1976).

Appendix (continued)

Common name	Scientific name	Symbol[1]
	GRASS AND GRASSLIKE PLANTS	
Baltic rush	*Juncus balticus*	JUBA
Bearded bluebunch wheatgrass	*Agropyron spicatum*	AGSP
Big bluegrass	*Poa ampla*	POAM
Blue wildrye	*Elymus glaucus*	ELGL
Bottlebrush squirreltail	*Sitanion hystrix*	SIHY
California brome	*Bromus carinatus*	BRCA
Cheatgrass	*Bromus tectorum*	BRTE
Creeping bentgrass	*Agrostis palustris*	AGPA
Crested wheatgrass	*Agropyron desertorum*	AGDE
Cusick bluegrass	*Poa cusickii*	POCU
Cutting wheatgrass	*Agropyron caninum*	AGCA
Desert saltgrass	*Distichlis stricta*	DIST
Douglas sedge	*Carex douglasii*	CADO
Drummond rush	*Juncus drummondii*	JUDR
Dunhead sedge	*Carex phaeocephala*	CAPH
Dwarf squirreltail	*Sitanion hystrix* var. *hordeoides*	SIHYH
Epapillous sedge	*Carex epapillosa*	CAEP
False-scirpus sedge	*Carex scirpoidea* var. *pseudoscirpoidea*	CASCP
Fescue	*Festuca* sp.	FESTU
Giant wildrye	*Elymus cinereus*	ELCI
Green fescue	*Festuca viridula*	FEVI
Hairgrass	*Deschampsia* sp.	DESCH
Idaho fescue	*Festuca idahoensis*	FEID
Indian ricegrass	*Oryzopsis hymenoides*	ORHY
Intermediate wheatgrass	*Agropyron intermedium*	AGIN2
Kentucky bluegrass	*Poa pratensis*	POPR
Lemmon needlegrass	*Stipa lemmonii*	STLE2
Liddon sedge	*Carex petasata*	CAPE
Longtongue mutton bluegrass	*Poa longiligula*	POLO
Medusahead wildrye	*Elymus caput-medusae*	ELCA2
Mountain hairgrass	*Deschampsia atropurpurea*	DEAT
Muhly	*Muhlenbergia richardsonis*	MURI
Needleandthread	*Stipa comata*	STCO2
Needlegrass	*Stipa* sp.	STIPA
Nevada bluegrass	*Poa nevadensis*	PONE2
Northern meadow barley	*Hordeum brachyantherum*	HOBR
One-spike oatgrass	*Danthonia unispicata*	DAUN
Oniongrass	*Melica* sp.	MELIC
Ovalhead sedge	*Carex festivella*	CAFE
Pacific fescue	*Festuca pacifica*	FEPA
Pinegrass	*Calamagrostis rubescens*	CARU
Prairie junegrass	*Koeleria cristata*	KOCR
Raynolds sedge	*Carex raynoldsii*	CARA
Ross sedge	*Carex rossii*	CARO
Rough fescue	*Festuca scabrella*	FESC
Rush	*Juncus* sp.	JUNCU
Sandberg bluegrass	*Poa sandbergii*	POSA3
Sedge	*Carex* sp.	CAREX
Sheep fescue	*Festuca ovina*	FEOV
Skyline bluegrass	*Poa epilis*	POEP
Slenderbeak sedge	*Carex athrostachya*	CAAT
Slender wheatgrass	*Agropyron trachycaulum*	AGTR

[1]After Garrison et al. (1976).

Appendix (continued)

Common name	Scientific name	Symbol[1]
Smallwing sedge	*Carex microptera*	CAMI
Smooth brome	*Bromus inermis*	BRIN
Spike rush	*Eleocharis* sp.	ELEOC
Spike trisetum	*Trisetum spicatum*	TRSP
Spreading woodrush	*Luzula divaricata*	LUDI
Subnigricans sedge	*Carex subnigricans*	CASU5
Swordleaf rush	*Juncus ensifolius*	JUEN
Threadleaf sedge	*Carex filifolia*	CAFI
Thurber needlegrass	*Stipa thurberiana*	STTH
Timothy	*Phleum pratense*	PHPR
Western needlegrass	*Stipa occidentalis*	STOC
Wheatgrass	*Agropyron* sp.	AGROP
Wheeler bluegrass	*Poa nervosa*	PONE
Winter bentgrass	*Agrostis scabra*	AGSC
	FORBS	
Alaska habenaria	*Habenaria unalascensis*	HAUN
Alpine shootingstar	*Dodecatheon alpinum*	DOAL
American bistort	*Polygonum bistortoides*	POBI
Annual agoseris	*Agoseris heterophylla*	AGHE
Arrowleaf balsamroot	*Balsamorhiza sagittata*	BASA
Ashy penstemon	*Penstemon humilis*	PEHU
Aster	*Aster* sp.	ASTER
Autum willowweed	*Epilobium paniculatum*	EPPA
Balsamroot	*Balsamorhiza* sp.	BALSA
Beckwith violet	*Viola beckwithii*	VIBE
Bedstraw	*Galium* sp.	GALIU
Beethistle	*Eryngium articulatum*	ERAR
Bighead clover	*Trifolium macrocephalum*	TRMA
Biscuitroot	*Lomatium* sp.	LOMAT
Bloomer fleabane	*Erigeron bloomeri*	ERBL
Bog-orchid	*Habenaria* sp.	HABEN
Buckwheat	*Eriogonum caespitosum*	ERCA
Cinquefoil	*Potentilla* sp.	POTEN
Clasping pepperweed	*Lepidium perfoliatum*	LEPE
Columbia monkshood	*Aconitum columbianum*	ACCO
Combleaf	*Polyctenium fremontii*	POFR2
Common dandelion	*Taraxicum officianale*	TAOF
Crag aster	*Aster scopulorum*	ASSC
Crisped starwort	*Stellaria crispa*	STCR
Daggerpod	*Phoenicaulis cheiranthoides*	PHCH
Dandelion	*Taraxicum* sp.	TARAX
Dwarf hesperochiron	*Hesperochiron pumilis*	HEPU
Dwarf monkeyflower	*Mimulus nanus*	MINA
Elkslip marshmarigold	*Caltha leptosepala*	CALE2
False agoseris	*Microseris troximoides*	MITR
False hellebore	*Veratrum* sp.	VERAT
Fleabane	*Erigeron* sp.	ERIGE
Gay penstemon	*Penstemon laetus*	PELA
Gray hawksbeard	*Crepis intermedia*	CRIN
Gray's biscuitroot	*Lomatium grayi*	LOGR
Halogeton	*Halogeton glomeratus*	HAGL
Hawksbeard	*Crepis* sp.	CREPI
Heartleaf arnica	*Arnica cordifolia*	ARCO

[1]After Garrison et al. (1976).

Appendix (continued)

Common name	Scientific name	Symbol[1]
Holboell rockcress	*Arabis hoelboellii*	ARHO
Hood's phlox	*Phlox hoodii*	PHHO
Hooker balsamroot	*Balsamorhiza hookeri*	BAHO
Kellogg's knotweed	*Polygonum kelloggii*	POKE
Lambstongue groundsel	*Senecio integerrimus*	SEIN
Locoweed	*Astragalus* sp.	ASTRA
Longleaf phlox	*Phlox longifolia*	PHLO
Lousewort	*Pedicularis attollens*	PEAT
Low pussytoes	*Antennaria dimorpha*	ANDI
Lupine	*Lupinus* sp.	LUPIN
Meadowrue	*Thalictrum* sp.	THALI
Milkvetch	*Astragalus* sp.	ASTRA
Modest buttercup	*Ranunculus verecundus*	RAVE
Nevada biscuitroot	*Lomatium nevadenses*	LONE
Newberry cinquefoil	*Potentilla newberryi*	PONE3
Nineleaf biscuitroot	*Lomatium triternatum*	LOTR
Nuttall violet	*Viola nuttallii*	VINU
Oblongleaf bluebells	*Mertensia obligifolia*	MEOB
Obscure milkvetch	*Astragalus obscurus*	ASOB
Peavine	*Lathyrus* sp.	LATHY
Phlox	*Phlox* sp.	PHLOX
Pink microsteris	*Microsteris gracilis*	MIGR
Plainleaf buttercup	*Ranunculus alismaefolius*	RAAL
Prairiesmoke avens	*Geum triflorum*	GETR
Primrose monkeyflower	*Mimulus primuloides*	MIPR
Pussytoes	*Antennaria* sp.	ANTEN
Rockcress	*Arabis* sp.	ARABI
Rocky Mountain parnassia	*Parnassia fimbriata*	PAFI
Roseroot stonecrop	*Sedum roseum*	SERO
Russianthistle	*Salsola kali*	SAKA
Scouler St. Johnswort	*Hypericum scouleri*	HYSC
Short-leaved cinquefoil	*Potentilla brevifolia*	POBR
Showy downingia	*Downingia elegans*	DOEL
Sierra willowweed	*Epilobium brevistylum*	EPBR
Skyrocket gilia	*Gilia aggregata*	GIAG
Slenderbush eriogonum	*Eriogonum microthecum*	ERMI
Sorrel	*Rumex* sp.	RUMEX
Spreading phlox	*Phlox diffusa*	PHDI
Spring draba	*Draba verna*	DRVE2
Spur lupine	*Lupinus laxiflorus*	LULA2
Starved milkvetch	*Astragalus miser*	ASMI
Stenophyllus pussytoes	*Antennaria stenophylla*	ANST
Stinging nettle	*Urtica dioica*	URDI
Tapertip hawksbeard	*Crepis acuminata*	CRAC
Thistle	*Cirsium* sp.	CIRSI
Tiny mousetail	*Myosurus minimus*	MYMI2
Varileaf phacelia	*Phacelia heterophylla*	PHHE
Violet	*Viola* sp.	VIOLA
Watson willowweed	*Epilobium watsonii*	EPWA
Western hawkweed	*Hieraceum albertinum*	HIAL2
White bogorchid	*Habenaria dilatata*	HADI2
Wild buckwheat	*Eriogonum* sp.	ERIOG
Woodlandstar	*Lithophragma bulbifera*	LIBU
Woolly eriophyllum	*Eriophyllum lanatum*	ERLA
Wyeth eriogonum	*Eriogonum heracleoides*	ERHE
Yarrow	*Achillea millefolium*	ACMI

[1]After Garrison et al. (1976).

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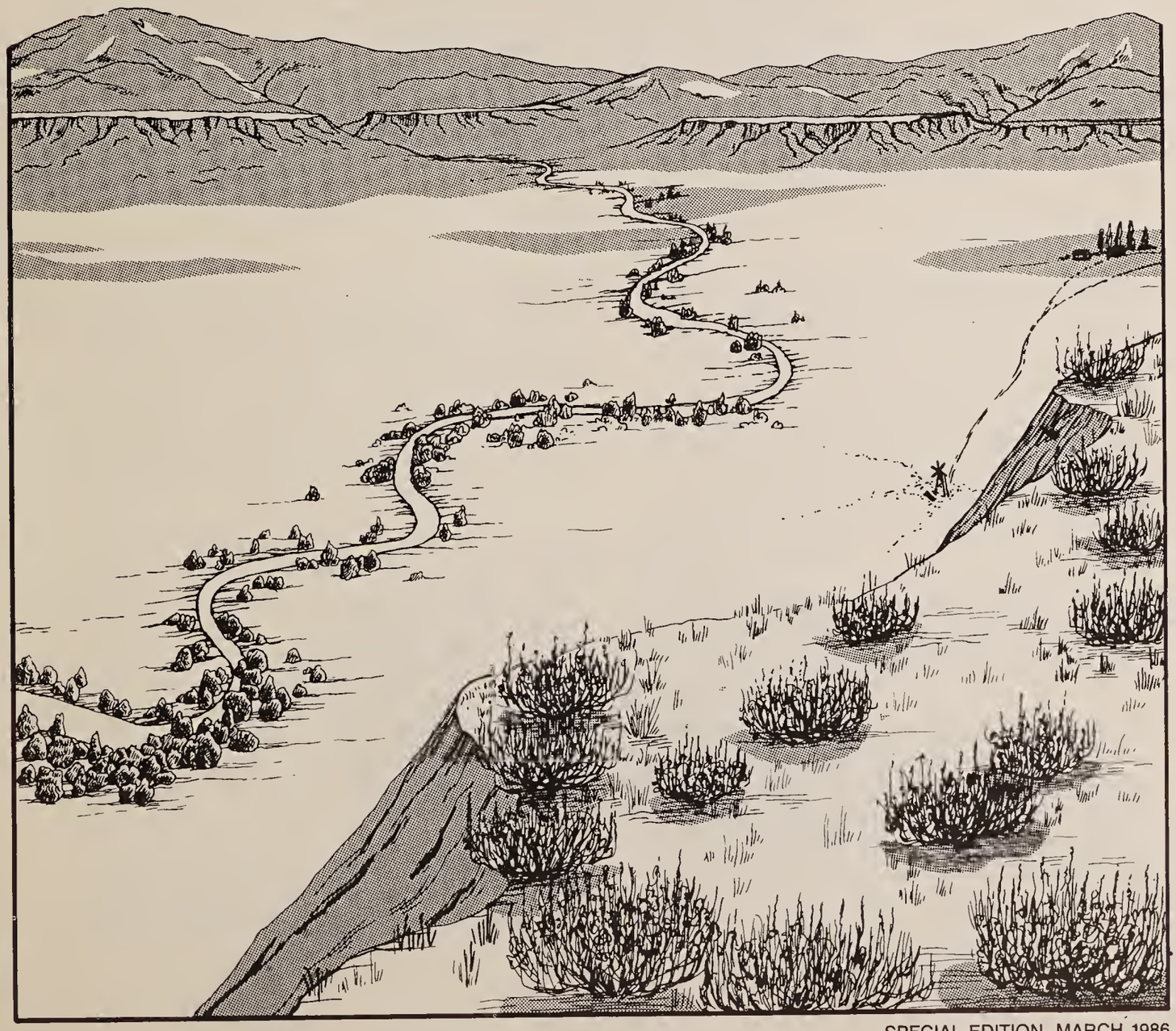
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

The Relationship of Terrestrial Vertebrates to Plant Communities, Part 1, Text

Chris Maser, Jack Ward Thomas, and Ralph G. Anderson



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ABSTRACT

The relationships of terrestrial vertebrates to plant communities, structural conditions, and special habitats in the Great Basin of southeastern Oregon are described. The importance of habitat components to wildlife and the predictability of management activities on wildlife are examined in terms of managed rangelands. The paper does not provide guidelines but rather shows a method of determining the consequences of potential management actions. The series of relationships discussed in Part 1 are given in the appendices that are in a companion publication, General Technical Report PNW-172, Part 2.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

The Federal rangeland manager must account for the impacts—whether good or bad—of management activities on all species of wildlife. The legal challenges, reviews, and court opinions that have emerged from conflicts over management of Federal rangeland have raised questions for which the land manager has had inadequate answers.

"Wildlife" has assumed a broader meaning in the last decade. No longer is wildlife defined by most land managers in terms of game species or confined to a relatively few species of special interest. The increasing recognition of ecological principles—everything is connected to everything else, and there is no such thing as a "free lunch" (Commoner 1971)—makes it mandatory that managers take a more holistic view of the system that they manage (Likens and Bormann 1972, McKell 1975, Maser and Thomas 1978, Odum 1969). For example, which species of wildlife will be adversely influenced, which benefited, and which unaffected by range management activities? What is the degree of impact on those species? How will the influences vary over time? Which negative impacts are irreversible and which can be reduced by appropriate management activity? Which species are especially sensitive to habitat change and how will they respond to habitat alterations? Which species are threatened and endangered and how will they be influenced?

Our purpose is to show how the range manager can deal with these problems in range management planning. The system described is designed to handle a large volume of technical information about wildlife and their habitats in a way that makes sense to the range manager. The approach was adapted from the work of Thomas et al. (1979) that, along with the contributions of Patton (1978), forms the basis for the Wildlife Habitats Relationships program of the USDA Forest Service. This national program will provide the approach and data base for the consideration of wildlife habitat in land-use planning on the National Forests. It is our intent to demonstrate the applicability of the technique and the approach to planning efforts on managed rangelands.

The first task was to assemble all pertinent data for the 341 species of vertebrates in the Great Basin of southeastern Oregon. The amount of data varied from extensive for some species to almost nothing for others. This presented two problems—what to do when information was inadequate and how to present information on a large number of species without overwhelming the manager with detail.

The second task was to weigh the impacts of range management activities on wildlife. There are basically two ways to consider wildlife in rangeland planning and management (Call 1978). The more traditional way is to develop management plans for one or several species of prime interest. But this does not take into account the habitat needs of all species. The approach used here is to consider habitat as the prime determinant of wildlife welfare and to associate wildlife with habitat condition.

Wildlife habitats also had to be identified in such a way that they could be considered simultaneously with range management for livestock. This was done by equating plant communities and their structural conditions with habitats for wildlife. (These structural conditions are: grass-forb → low shrub → tall shrub → tree → tree/shrub. As a plant community progresses from the grass-forb condition through the tree/shrub condition, the cumulative effect of the existing plant species' growth forms increases the structural diversity of the plant community or condition. For example, a grass + a forb condition has a certain diversity of structure, but a grass + a forb + a shrub + a tree obviously has a far greater diversity of structure. Since this structural diversity is measurable, both qualitatively and quantitatively, we use the term structural condition.)

Previous applications of this approach have used plant communities and successional stages as the primary habitat classification (Thomas et al. 1979, Verner and Boss 1980). These efforts dealt primarily with forested areas where succession is better understood, more predictable, and more obvious than in rangeland conditions. Within rangeland plant communities, however, there is an array of structural conditions that are recognizable and can be interpreted as a

habitat condition. We therefore used structural conditions by plant community as the descriptor of habitats. These structural conditions are the result of the natural growth and development of plant communities, as altered by management activities such as controlling brush, grazing with domestic livestock and wild ungulates, fencing, maintenance of grazing systems, planting or seeding trees or grass, and thinning forest stands. The plant community was accepted as an integrator of all environmental variables on the site (Daubenmire 1975, 1976; Feldhamer 1979; Sauer and Uresk 1976). By associating individual wildlife species and groups of species with plant communities and an array of structural conditions (fig. 1), the rangeland manager can translate standard range inventories into information on wildlife habitats.

Only enough information is presented in this paper (Part 1) to describe the principles and procedures on which the wildlife relationships for the Great Basin in southeastern Oregon are based. Ecological information for all terrestrial vertebrates is included in the appendices that form Part 2 of General Technical Report PNW-172. This companion publication is primarily of interest to persons working in the geographical area described. Those who need the appendices should refer to the following:

Maser, Chris; Thomas, Jack Ward; Anderson, Ralph G. Wildlife habitats in managed rangelands—the Great Basin of southeastern Oregon: the relationship of terrestrial vertebrates to plant communities and structural condition. Gen. Tech. Rep. PNW-172, part 2 of 2 parts. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1984. 237 p.

Copies may be obtained from either of the following:

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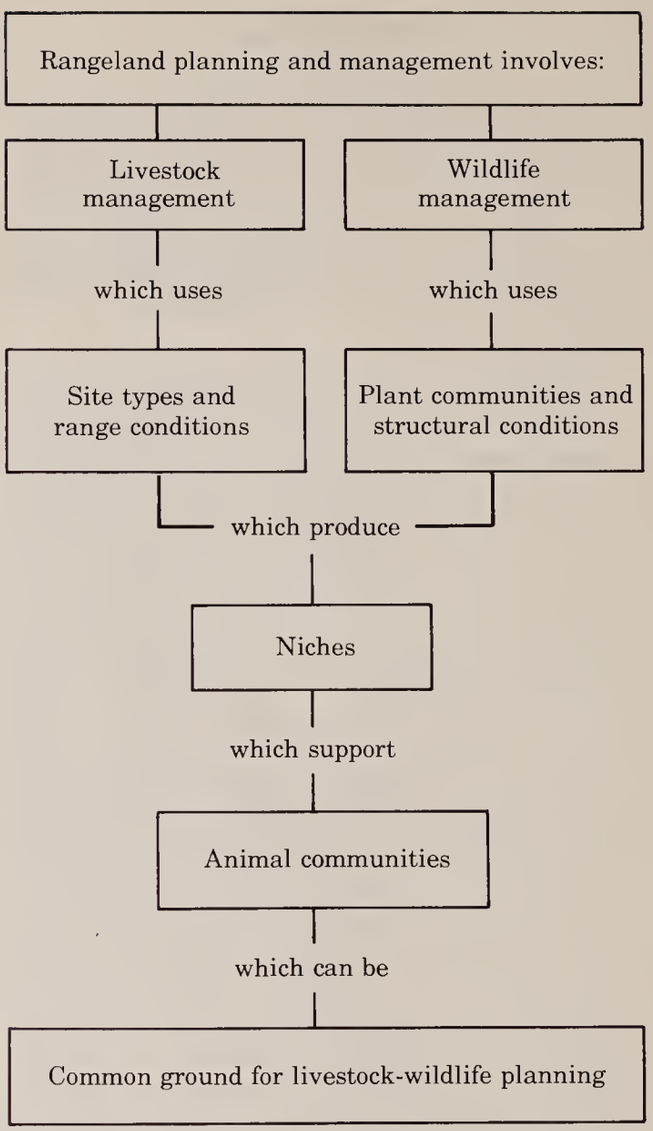


Figure 1.—Plant communities and their structural conditions can be a common ground for livestock-wildlife planning.

Plant Community Descriptions

The starting point for describing the plant communities was the classification of the ecosystems of the Great Basin in southeastern Oregon by Dealy et al. (1981). This classification required some modification to bring it in line with other systems already in use by rangeland managers. Because most wildlife respond more to vegetative structure than to plant species composition (Black 1968, Larrison and Johnson 1973, Maser and Thomas 1978, Olson

1974, Rotenberry and Wiens 1980, Tester and Marshall 1961, Turcek 1972), structurally similar ecosystems were grouped and others were divided or identified as structurally distinct and important wildlife habitats. In other words, ability of plant ecologists to differentiate between plant communities exceeds the present ability of wildlife biologists to detect differences in animal communities. When no demonstrated differences existed in animal communities between structurally similar plant communities, the communities were combined.

The modifications described in figure 2 show the relationship between the ecosystems described by Küchler (1964) and Dealy et al. (1981).

Wildlife Habitat Relationships

Wildlife habitats and their structural conditions have unique environmental conditions that are ecologically important as habitat niches for wildlife species (fig. 3). The habitat niches are a product of the plant community, its structural conditions, and other environmental factors—including soil type, moisture regime, microclimate, slope aspect, elevation, and temperature. The complex interactions of site and plant community structure could be dissected and the more precise influence of each on the animal community determined. If such information existed, it would probably be too complex to use readily. The plant community type, however, can be considered an integrator of the many factors interacting on the site.

Wildlife species are individually adapted to combinations of plant community and structural condition for feeding, or reproduction, or both. These wildlife-habitat relationships provide the basic information from which the informational displays (tables, figures, and companion appendices) were developed. Depending on their requirements, rangeland managers and planners can extract information at four levels of detail. The amount of detail increases with each level:

Level 1. The relationship of animal life forms for feeding and reproduction to plant communities and plant community structural conditions. Life forms are groups of wildlife species that exhibit similar habitat requirements for both feeding and reproduction.

Level 2. The relationship of individual species for feeding and reproduction to plant communities and plant community structural conditions.

Level 3. A summary of the available biological data for each species.

Level 4. Selected references on habitat relationships for each species. Examination of these references and their bibliographies can provide the user with more detailed data and additional sources of information.

The information on each species in level 2 has been used to develop a relative measure of vulnerability of each species to habitat manipulation. This is another source of information for the manager's use.

The informational displays were constructed from: (1) the literature, (2) interpretation and extrapolation of information in that literature, (3) 3 years of fieldwork in the area, and (4) a consensus of cooperating wildlife biologists. In all cases, in our judgment, the best available information was used. If the literature was specific to the Great Basin of southeastern Oregon and, in our opinion, contained the required information, it was used. If the literature was not specific to the area or habitat condition, it was adapted as appropriate. In the absence of published information or field data, the relationship of the species to habitat was determined by consensus of the consulting biologists. Data for the most intensively studied species were, naturally, more voluminous and detailed than for relatively obscure species. As new information becomes available, it can be added to the system.

Natural vegetation as described by Küchler (1964)	Communities of the Great Basin in southeastern Oregon as described by Dealy et al. (1981)	Plant communities as used here to describe animal habitats
37 Mountainmahogany-oak shrub (similar position – not equal)	Curlleaf mountainmahogany/mountain big sagebrush/bunchgrass Curlleaf mountainmahogany/mountain snowberry/grass	Curlleaf mountainmahogany/shrub
	Curlleaf mountainmahogany/pinegrass	Curlleaf mountainmahogany/pinegrass
	Curlleaf mountainmahogany/Idaho fescue Curlleaf mountainmahogany/bearded bluebunch wheatgrass – Idaho fescue	Curlleaf mountainmahogany/bunchgrass
No provision	Squaw apple/bunchgrass	Squaw apple/bunchgrass
55 Sagebrush steppe (with juniper)	Western juniper/big sagebrush/bearded bluebunch wheatgrass Western juniper/big sagebrush/Idaho fescue	Juniper/sagebrush/bunchgrass
55 Sagebrush steppe	Basin big sagebrush/bunchgrass Wyoming big sagebrush/bunchgrass Mountain big sagebrush/bunchgrass Threetip sagebrush/bunchgrass Bolander silver sagebrush/bunchgrass Mountain silver sagebrush/bunchgrass Subalpine big sagebrush/bunchgrass	Tall sagebrush/bunchgrass
	Stiff sagebrush/bunchgrass Low sagebrush/bunchgrass Cleftleaf sagebrush/bunchgrass Early low sagebrush/bunchgrass Black sagebrush/bunchgrass	Low sagebrush/bunchgrass
40 Saltbush-greasewood	Black greasewood/grass	Black greasewood/grass
	Shadscale saltbush/bunchgrass	Shadscale saltbush/bunchgrass
No provision	Riparian	Riparian
	Permanently wet meadows	Permanently wet meadows
	Seasonally wet meadows	Seasonally wet meadows
	Quaking aspen/mountain big sagebrush	Quaking aspen/mountain big sagebrush/bunchgrass
	Quaking aspen/grass	Quaking aspen/grass
52 Alpine meadows and barren (similar – not equal)	Subalpine bunchgrass	Subalpine bunchgrass
No provision	No provision	Crested wheatgrass (seeded)

[1] Scientific names are given in appendix 14.

Figure 2.—Relationships between plant communities described in this chapter and two other plant classification systems.

Environmental variable	Structural conditions: Grass-forb	Low shrub	Tall shrub	Tree	Tree/shrub
Vegetation height	•	••	•••	•••••	•••••
Canopy closure	•	•••	••••	•••	•••••
Canopy volume	•	•••	••••	•••	•••••
Plant diversity	••	•••	•••	•	•••
Structural diversity	•	••	•••	••••	•••••
Forage production	•••••	•••	••••	••	•
Browse production	•	••••	•••••	••	•••
Animal diversity	•	••	•••	••••	•••••

Figure 3.—Generalized structural conditions of range and related environmental variables. The number of dots do not reflect relative values, but a range from • = least to ••••• = most.

Level 1: Life Form Association With Plant Communities And Successional Stages

The large number of wildlife species present in most areas makes it difficult for the land manager to account for them in the land-use planning process. In the case of the Great Basin this number was reduced from 341 species (appendix 1, Part 2) to 16 life forms (table 1, this paper). The relationship of the species to their habitats is the basis for grouping them into life forms. This life form concept was adapted by Thomas et al. (1979) from Haapanen's (1965) division of birds of the Finnish forests into groups based on specific combinations of habitat requirements for reproduction and feeding. The concept was expanded to include all terrestrial vertebrates. The species are also listed phylogenetically by their common and scientific names in appendix 1 and alphabetically by computer codes in appendix 2.

Grouping species by life forms is distinctly different from the usual grouping of species by morphological characteristics. It enables the rangeland manager to evaluate the response of wildlife to habitat much more readily than if each species were considered individually. If this concept is applicable in land-use planning, new and different life forms will most likely be developed. They can be changed as needed to fit the circumstances. This concept can be used to satisfy the planning requirements of the regulations issued pursuant to the Federal Land Policy and Management Act (U.S. Laws, Statutes, etc., Public Law 94-579, 1976) and to the National Forest Management Act (U.S. Laws, Statutes, etc., Public Law 94-588, 1976), which requires management by "indicator species" and requires identification of the wildlife where welfare is reflected by the welfare of the indicator.

The relationship of vertebrate life forms to plant communities and structural conditions is shown in appendix 3, to overstory and understory in table 2, and is summarized by overstory in appendix 4. Seventy-two of the 341 species that occur in the Great Basin of southeastern Oregon do not appear in this listing or in subsequent discussions. Seventy bird species either migrate through or are incidental in the Great Basin of southeastern Oregon. The bullfrog and the spotted frog, the only species in life form 1, have also been omitted as they are semiterrestrial. The 70 bird species and the 2 mammals excluded are listed in appendix 5.

Life form 7 is used as an example of how the system works. The species in life form 7 feed in shrubs, trees, or air, and reproduce in shrubs. In the Great Basin in southeastern Oregon, the life form contains 29 species.

Much useful information can be derived from the following data sets. Table 2, for example, shows that: (1) life form 7 is strongly associated with shrub-dominated communities, (2) some shrub-dominated communities, such as juniper/sagebrush/bunchgrass, curlleaf mountain-mahogany/shrub, quaking aspen/bunchgrass,

Table 1—Life form descriptions

Life form	Reproduces	Feeds	No. of species[1]	Examples
1	in water	in water	2	bullfrog
2	in water	on ground, in shrubs and/or trees	6	long-toed salamander, western toad, Pacific treefrog
3	on ground around water or on floating or emergent vegetation	in water, on ground, in shrubs and trees	44	common garter snake, killdeer
4	in cliffs, caves, rims, and/or talus	on ground or in air	33	western fence lizard, common raven, spotted skunk
5	on ground without specific water, cliff, rim, or talus association	on ground	45	short-horned lizard, northern junco, mule deer
6	on ground	in shrubs, trees, or air	4	common nighthawk, orange-crowned warbler
7	in shrubs	on ground, in water or air	29	American robin, Swainson's thrush, chipping sparrow
8	in shrubs	in shrubs, trees, or air	5	yellow-billed cuckoo, bushtit
9	primarily in deciduous trees	in shrubs, trees, or air	3	house finch
10	primarily in conifers	in shrubs, trees, or air	10	pinyon jay, Townsend's warbler
11	in trees	on ground, in shrubs, trees, or air	13	sharp-shinned hawk, American crow
12	on very thick branches	on ground or in water	6	great blue heron, golden eagle
13	excavates own hole in a tree	on ground, in shrubs, trees, or air	9	common flicker, Williamson's sapsucker
14	in a hole made by another species or naturally occurring	on ground, in water, or air	25	American kestrel, mountain bluebird
15	underground burrow	on or underground	32	burrowing owl, kit fox
16	underground burrow	in water, on ground, or in air	9	bank swallow, muskrat
	Total species		275	

[1] Species assignment to life form is based on predominant habitat-use patterns.

Table 2—Relative degree of use of plant communities and structural conditions by wildlife species in life form 7 (source: appendix 3)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: grass-forb B.G.	grass-forb Ann.	grass-forb Bunch.	**low shrub B.G.**	**low shrub Ann.**	**low shrub Bunch.**	tall shrub B.G.	tall shrub Ann.	tall shrub Bunch.	tree B.G.	tree Ann.	tree Bunch.	tree/shrub B.G.	tree/shrub Ann.	tree/shrub Bunch.
crested wheatgrass (seeded)	R 0		0	0	These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 1		1	1												
subalpine bunchgrass	R 0		0	0												
	F 1		1	1												
permanently wet meadows	R 3		3	0												
	F 10		8	1												
seasonally wet meadows	R 3		3	0												
	F 10		8	0												
shadscale saltbush/ bunchgrass	R 0		0	0		0	0									
	F 9		4	1		6	4									
low sagebrush/bunchgrass	R 4		0	0		0	0									
	F 14		5	2		8	6									
black greasewood/grass	R 1		0	0		0	0		0	1						
	F 12		5	2		9	6		12	9						
tall sagebrush/bunchgrass	R 18		3	0		6	3		18	14						
	F 21		5	2		12	10		21	18						
squaw apple/bunchgrass	R 2		0	0		1	1		2	2						
	F 15		4	1		11	8		15	12						
curlleaf mountainmahogany/ bunchgrass	R 4		0	0		1	1		4	4		2	2			
	F 19		6	2		13	10		19	16		14	12			
curlleaf mountainmahogany/ pinegrass	R 4		0	0		1	1		4	4		2	2			
	F 19		6	2		13	10		19	16		14	12			
juniper/sagebrush/ bunchgrass	R 18		2	0		4	2		17	13		11	7		18	14
	F 25		8	2		15	11		25	20		19	15		25	21
curlleaf mountainmahogany/ shrub	R 14		0	0		2	2		13	11		7	4		13	10
	F 26		8	2		15	11		26	21		20	16		26	22
quaking aspen/grass	R 19		3	0		4	1		19	11		14	7		18	11
	F 24		9	2		14	10		24	17		20	14		24	18
quaking aspen/mountain big sagebrush/bunchgrass	R 25		3	0		6	3		25	17		15	8		24	17
	F 28		9	2		15	11		28	21		22	16		28	22
riparian	R 23		3	0		4	1		21	14		14	7	1	22	15
	F 25		10	3		14	10		24	17		20	14	0	24	18

quaking aspen/mountain big sagebrush, and riparian, are disproportionately important, and (3) the tall shrub, tree, and tree/shrub structural conditions are critical. Reproductive and feeding orientation to plant community types and plant community structural conditions can be determined for the entire life form.

By examining the relationship of the life form to plant communities and their structural conditions, the rangeland manager can judge the impact of range mangement practices on the life form (Reynolds and Trost 1979, 1980, 1981; Rogers and Hedlund 1980). This is done by determining the importance (expressed by the number of species) of a particular structural condition of a community. The impact of a contemplated management action is determined by comparing the two numbers for the structural conditions involved.

Consider, for instance, the importance of the juniper/sagebrush/bunchgrass community in the tree/shrub/annuals structural condition. Of the 29 species in the life form, 25 feed and 18 reproduce there. Suppose a manager is contemplating two courses of action on a particular area: (1) removing the trees and shrubs to enhance forage production for domestic and wild ungulates, thereby altering the vegetative condition to the grass-forb stage or (2) encourage the replacement of the annual vegetation with mature bunchgrasses. What are the consequences of each alternative to life form 7?

Reduction to the grass-forb structural condition would reduce to 0 the number of species reproducing and to 2 the number finding feeding habitat. This extremely adverse impact would continue for about 10-20 years after initial regeneration of the juniper and sagebrush. At that time, the stand would enter the structural condition (tall shrub with bunchgrasses) where 20 species feed and 13 reproduce. Full recovery of the habitat for life form 7 would not occur until the stand was about 40-60 years old and had returned to the tree/shrub/annuals structural condition.

A decision to allow the stand to progress from the tree/shrub/annuals structural condition to the tree/shrub/bunchgrass state would have a small negative effect on the life form because 21 species feed and 14 species reproduce there.

Obviously, if the manager considered factors such as the percentage of the area affected, the distribution of plant communities and structural conditions, and anticipated changes over time, a more sophisticated analysis could be made. But the same basic comparisons would be used.

The displays in appendix 3 can be used to predict the response of animal life to all alterations in the plant community, whether artificial or natural. Such alterations could result from natural phenomena, such as fire, insect infestation, or windstorm, or from management activities like seeding, planting, herbicide treatment, or fertilization.

Any of these actions would change the structural condition to another state—usually a more simplified one (table 3) (Mack 1981, Rickard and Cline 1980, Thomas et al. 1979). For example, planting trees introduces another vegetative layer and adds diversity, but wildfire removes trees and shrubs and simplifies the vegetative structure. Because wildlife is mainly a product of the vegetative structure of a community and not the age of the vegetation, it is possible to predict the effect of various manipulations of vegetation on wildlife.

Level 2: Relationship of Species To Plant Communities And Structural Conditions

The responses of vertebrate life forms to plant communities and structural conditions can be generalized. But the response of each species within a life form varies because of specific habitat requirements. Level 2 shows orientation to plant community and structural conditions for each species. Species are grouped by life form to facilitate comparison with information in level 1. The primary orientation to plant communities by species within life forms is illustrated for life form 7 in table 4. Similar information for all life forms is in appendix 6. Information on species orientation to structural conditions is illustrated in table 5; complete information for all life forms is in appendix 7.

Table 3—Anticipated changes in range-community structural conditions due to management action

Management action	Grass-forb	Low shrub	Tall shrub	Tree	Tree/shrub
Weed control	◄	►	►	–	–
Brush control:					
Chemical		◄	◄		◄
Mechanical		◄	◄		◄
Biological		◄	◄		◄
Tree control:					
Chain and doze				◄	◄
Clearcutting				◄	◄
Shelterwood				◄	◄
Thin				◄	◄
Salvage				◄	◄
Debris disposal				◄	◄
Controlled burn:					
Cold	◄	◄	◄	–	◄
Hot	◄	◄	◄	◄	◄
Seeding and planting:					
Grasses and forbs	►	◄	◄	◄	◄
Shrubs	►	–	–	►	–
Trees	►	►	►	–	–
Fertilization	–	◄►	◄►	◄►	◄►
Mechanical soil treatment:					
Pitting	◄	◄	◄	◄	◄
Contouring	◄	◄	◄	◄	◄
Water:					
Water spreading	◄	◄	◄	◄	◄
Drainage	►	►	►	►	►
Water development	◄	◄	◄	–	–
Grazing:					
Cattle	◄►	◄►	◄►	–	–
Horses	◄►	◄►	◄►	–	–
Sheep	◄►	◄	◄	–	◄
Goats	◄►	◄	◄	–	◄

► increased structural diversity;
◄ decreased structural diversity;
◄► increases or decreases structural diversity depending upon type and/or level of application;
– no effect on structural diversity;
(blank space) not a viable practice.

Table 4—Orientation of wildlife species in life form 7 to plant communities (source: appendix 6)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
						• – Primary (≥40%) reproduction and feeding								r – Secondary (<40%) reproduction only					
						0 – Secondary (<40%) reproduction and feeding								F – Primary (≥40%) feeding only					
						R – Primary (≥40%) reproduction only								f – Secondary (<40%) feeding only					
	BIRDS																	R	F
BUST	green heron																•	1	1
BUIB	cattle egret	f		F	F				0						•	•	•	3	5
NYNY	black-crowned night heron			F	F				0						•	•	•	3	5
BUSW	Swainson's hawk			f	f	f	F	F	•	f	F	F	•	F	•	•	•	5	10
STCAL	calliope hummingbird			F	F								•	•	•	•	•	5	7
CAAN	Anna's hummingbird			F	F								•	•	•	•	•	5	7
TYTY	eastern kingbird						f	f	•	f	F	F	•	•	•	•	•	6	8
EMTR	willow flycatcher					F	F	F	F	F	F	F	F	F	•	•	•	3	12
EMWR	gray flycatcher					F	F	F	•	F	•	•	•	•	•	•	F	7	12
APCO	scrub jay			F	F		f	f	•	f	•	•	•	•	F	F	•	6	10
PIPI	black-billed magpie	F	F	F	F	F	F	F	•	•	•	•	•	•	•	•	•	9	16
DUCA	gray catbird						f	f	F	F	F	F	F	F	•	•	•	3	9
TORV	brown thrasher					f	•	F	•	F	F	F	•	•	F	•	•	6	11
ORMO	sage thrasher						F	F	•	F	f	f	•	•	f	•	f	4	7
TUMI	American robin			F	F				f		F	F	F	F	•	•	•	3	9
CAUS	Swainson's thrush						f	f	•	f	F	F	F	F	•	•	•	4	8
PACAE	blue-gray gnatcatcher								•	f	f	f	•	F	F	•	F	3	6
LALU	loggerhead shrike					F	F	•	•	F	F	F	•	•	F	F	•	5	12
AGPH	red-winged blackbird			•	•	F	F	F	•	F	F	F	F	F	•	•	•	6	14
EUCY	Brewer's blackbird	f		•	•	F	F	F	•	F	F	F	•	F	•	•	•	7	14
MOAT	brown-headed cowbird	f		•	•	F	F	F	•	F	F	F	•	F	•	•	•	7	14
PAAMO	lazuli bunting								f	f	f	f	f	F	•	•	•	3	4
CAPS	lesser goldfinch								f	F	F	F	F	•	•	•	•	4	8
PICH	green-tailed towhee					F	F	F	•	•	•	•	F	•	F	•	f	6	11
PIER	rufous-sided towhee					f	f	f	•	F	F	F	•	•	•	•	•	6	9
AMBE	sage sparrow						•	f	•	f	f	f	•	•	f	•	f	5	5
SPPA	chipping sparrow							f	F	F	F	F	•	•	•	•	•	5	9
SPBRE	Brewer's sparrow						•	f	•	f	f	f	•	F	f	•	f	4	5
NEMEL	song sparrow					F	•	F	•	F	F	F	•	F		F	•	4	11
	Total	R 0	0	3	3	0	4	1	18	2	4	4	18	14	19	25	23		
		F 1	1	10	10	9	14	12	21	15	19	19	25	26	24	28	25		

Table 5—Orientation of wildlife species in life form 7 to structural conditions (source: appendix 7)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
BUST	green heron		F	F		F	F							R	R	R	3	4
BUIB	cattle egret		F						•			•			•		3	4
NYNY	black-crowned night heron								•			•			•		3	3
BUSW	Swainson's hawk		F	F		F	F		•	•		•	•		•	•	6	10
STCAL	calliope hummingbird		F			F			•			•			•		3	5
CAAN	Anna's hummingbird		F						•			•			•		3	4
TYTY	eastern kingbird						F		•	F		•	F		•	F	3	7
EMTR	willow flycatcher					F	F		•	•		•	•		•	•	6	8
EMWR	gray flycatcher								•	•		•	•		•	•	6	6
APCO	scrub jay								•	•		F	F		•	•	4	6
PIPI	black-billed magpie		F	F		F	F		•	•		•	•		•	•	6	10
DUCA	gray catbird					F	F		•	•		f	f		•	•	4	6
TORV	brown thrasher					F	F		•	•					•	•	4	6
ORMO	sage thrasher								•	•					•	•	4	4
TUMI	American robin		F			F	f		•	•		•	•		•	•	6	8
CAUS	Swainson's thrush								•	•		F	F		•	•	4	6
PACAE	blue-gray gnatcatcher								•	•		•	•		•	•	6	6
LALU	loggerhead shrike					F	F		F	•		•	•		•	•	5	8
AGPH	red-winged blackbird		•			•			•			•			•		5	5
EUCY	Brewer's blackbird		•			•			•			•			•		5	5
MOAT	brown-headed cowbird		•			•			•			•	•		•	•	7	7
PAAMO	lazuli bunting								•	•		F	F		•	•	4	6
CAPS	lesser goldfinch					F	F		•	•		F	F		F	F	2	8
PICH	green-tailed towhee					•	•		•	•					•	•	6	6
PIER	rufous-sided towhee					•	•		•	•					•	•	6	6
AMBE	sage sparrow								•	•		F	F		•	•	4	6
SPPA	chipping sparrow								•	•		•	•		•	•	6	6
SPBRE	Brewer's sparrow					•	•		•	•		F	F		•	•	6	8
NEMEL	song sparrow								•	•					•	•	4	4
	Total	R	0	3	0	0	6	3	0	27	20	0	16	9	1	28	21	
		F	0	10	3	0	16	12	0	28	21	0	22	16	0	28	22	

• – Primary (≥40%) reproduction and feeding

0 – Secondary (<40%) reproduction and feeding

R – Primary (≥40%) reproduction only

r – Secondary (<40%) reproduction only

F – Primary (≥40%) feeding only

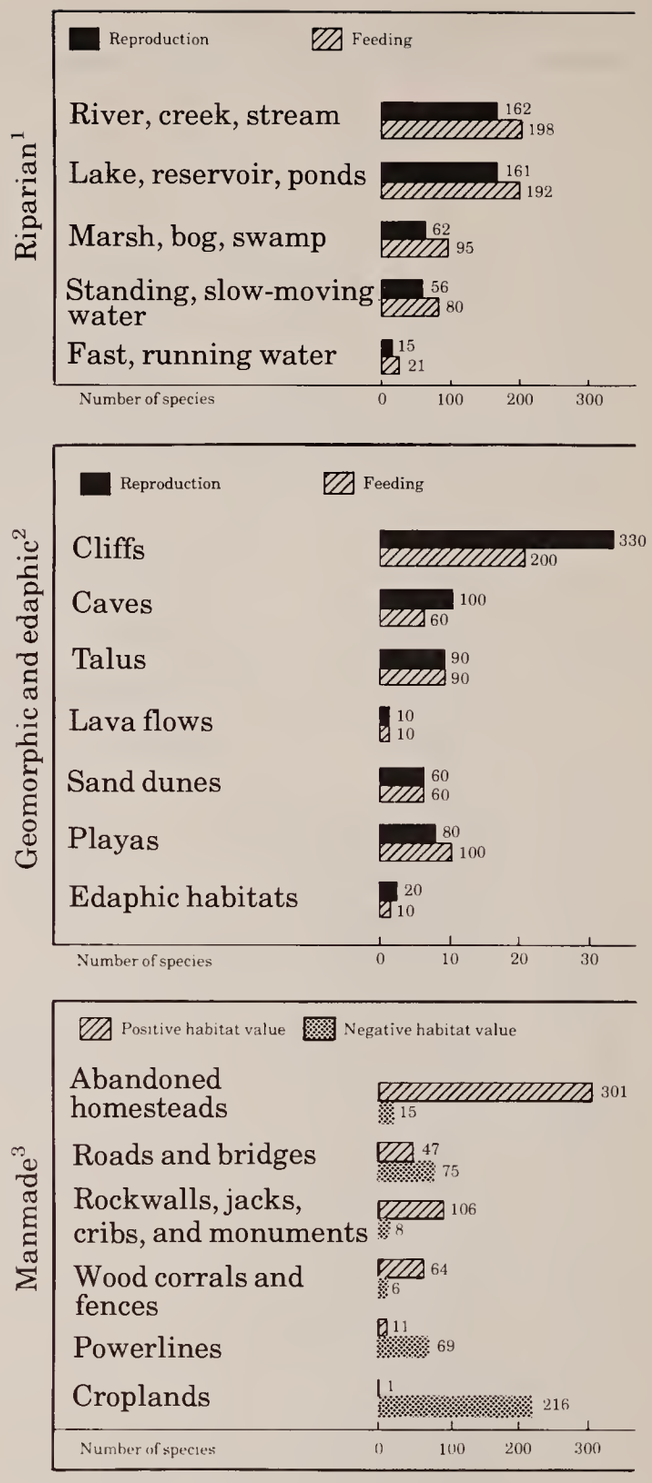
f – Secondary (<40%) feeding only

The use of plant communities and structural conditions by a particular species can be determined from appendices 6 and 7. Table 4 contains information on the orientation of species to plant communities for feeding and reproduction. Table 5 shows the use of structural conditions by each species. The two sets of information must be considered in tandem—one before the other. For example, the willow flycatcher shows orientation to the community for feeding only (table 4). This means that information on reproduction in table 5 should be disregarded for the willow flycatcher in the juniper/sagebrush/bunchgrass community.

Wildlife obviously have habitat requirements other than plant community and structural condition. Orientations to special habitat components are shown for all life forms in appendix 8. Orientation of species to artificial habitats is discussed by Maser et al. (1979b) and association with geomorphic and edaphic habitats by Maser et al. (1979a). The importance of these special and unique habitat components, as reflected by the number of wildlife species using them, is shown in figure 4.

Additional information may be derived from appendices 6 and 7. The total number of species oriented to each plant community and structural condition for feeding and reproduction was used to produce appendix 3 and table 2, which demonstrate the orientation of the life form. In other words, to develop the information on life form (level 1) the information for individual species in level 2 must first be completed.

The information in level 2 has a variety of uses. For example, the importance of each community and structural condition can be evaluated in terms of its ability to provide habitat for different species. In each planning scenario, the rangeland manager can examine the impact of proposed management actions on wildlife—individual species or all wildlife. The information can also be used to determine the role of plant communities as habitat for featured species or for rare and endangered species.



[1] Source: appendix 8.
[2] Source: Maser et al. 1979b.
[3] Source: Maser et al. 1979a.

Figure 4.—Number of terrestrial vertebrate wildlife species using special and unique habitats.

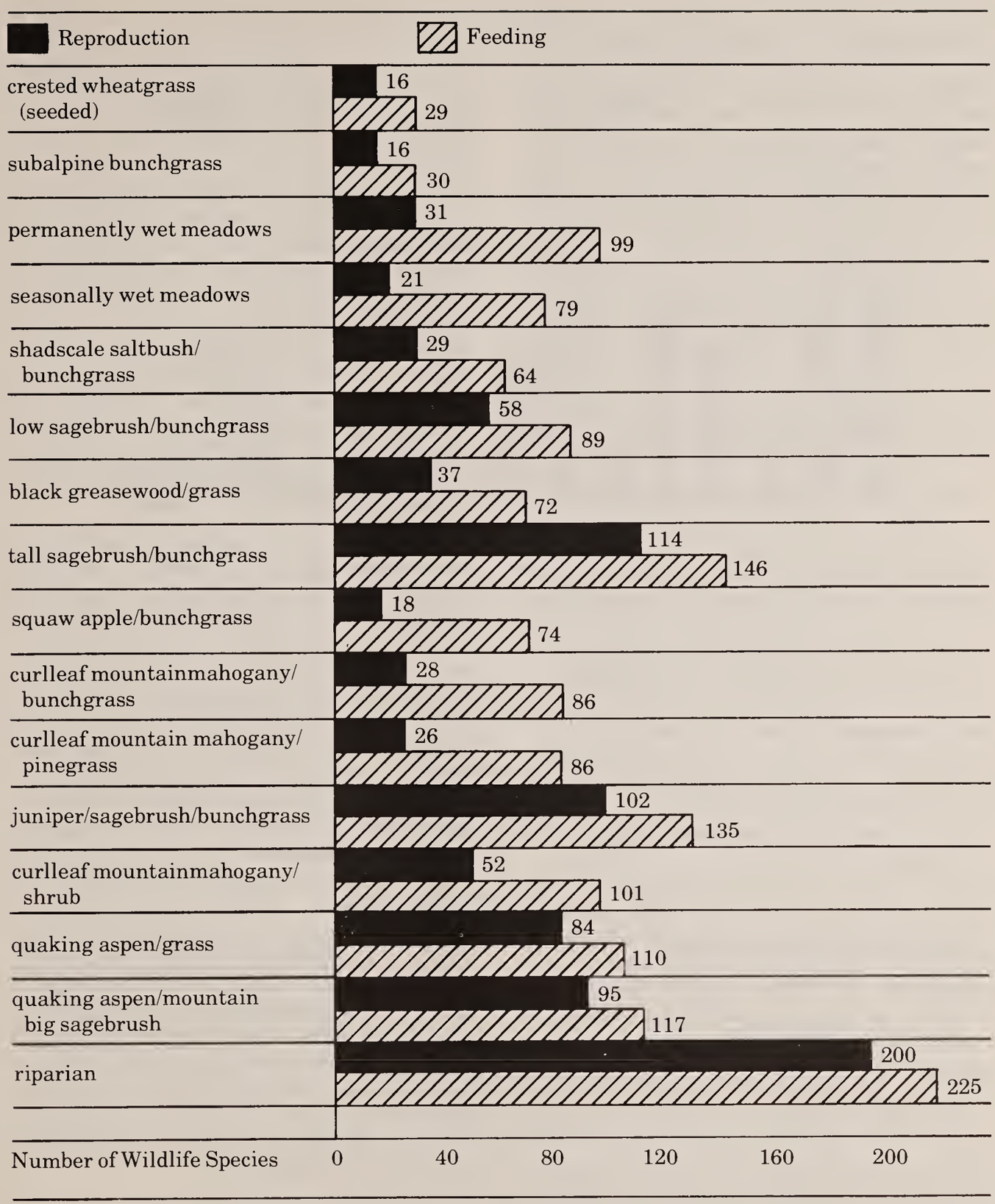


Figure 5.—Number of wildlife species oriented to desert-steppe plant communities for feeding and reproduction (source: appendix 6).

Some rangeland communities obviously produce more species of wildlife than others (fig. 5). The tall sagebrush/bunchgrass, juniper/sagebrush/bunchgrass, and riparian communities in the Great Basin of southeastern Oregon—those communities most affected by range management when enhancing forage production for domestic and wild ungulates—are also the most productive in terms of wildlife.

Figure 6 shows that the more complex structural conditions (tall shrub, tree, or tree/shrub) in the juniper/sagebrush/bunchgrass community are important to more species than are the simpler structural conditions (grass-forb and low shrub). Habitat for reproduction is also more restrictive than habitat for feeding. A similar display for all plant communities is shown in appendix 9.

Using the same data, the rangeland manager can predict the response of individual species to alterations in a structural condition. For example, a series of shrub and tree removal operations might be planned in an extensive area covered by the tree/shrub structural condition of the juniper/sagebrush/bunchgrass plant community. The intentions of the operation are to remove most of the tree and shrub canopy and to increase the density and biomass of the bunchgrasses and forbs. What wildlife species are likely to be affected? In an actual analysis, the information on each species in each life form would be examined (appendices 5 and 6). As an example, consider the data for life form 7 (table 4). Of the 29 species in life form 7, 18 (see table 4 for species' names) have a primary association with the juniper/sagebrush/bunchgrass plant community for both feeding and reproduction. In addition, seven species have a primary association and one has a secondary association for feeding only.

In this situation, what effect would removal of most of the tall shrubs and mature juniper cover have on those species? Removal or killing of the shrubs and trees would put those areas into the grass-forb structural condition. Table 5 shows that 14 of the 18 species are primarily associated with the tree/shrub/bunchgrass structural condition for both feeding and reproduction as are six of the seven showing primary orientation for feeding only. One species shows primary association to the plant community for both feeding and reproduction but only feeds in the tree/shrub/bunchgrass structural condition and reproduces in the tree/shrub/annuals structural condition. It can be concluded that such action will reduce habitat for those species by approximately 35 percent for at least 40-50 years—the time required for the stand to regenerate and reach a structural condition suitable for reoccupancy.

At the same time, some species would benefit from the early structural conditions that follow tree and shrub removal. Table 5 (or appendix 7) shows that two species (red-winged blackbird and Brewer's blackbird) would find primary nesting and feeding habitat in the changed condition and four species (cattle egret, Swainson's hawk, calliope hummingbird, and Anna'a hummingbird) would feed in such conditions. These species would gradually drop out as conditions changed back toward the original state and the original species that occupied the site might be expected to reappear.

As another example, consider the generalized relationship of wildlife in the Great Basin of southeastern Oregon to structural conditions of rangeland communities (fig. 7). This shows why many people are concerned about the effects of intensive range management to improve domestic and wild ungulate grazing on wildlife diversity and on the welfare of species that are narrowly adapted to certain structural conditions, particularly tall shrub, low shrub, tree, and tree/shrub (Baker et al. 1976, Maser and Gashwiler 1978).

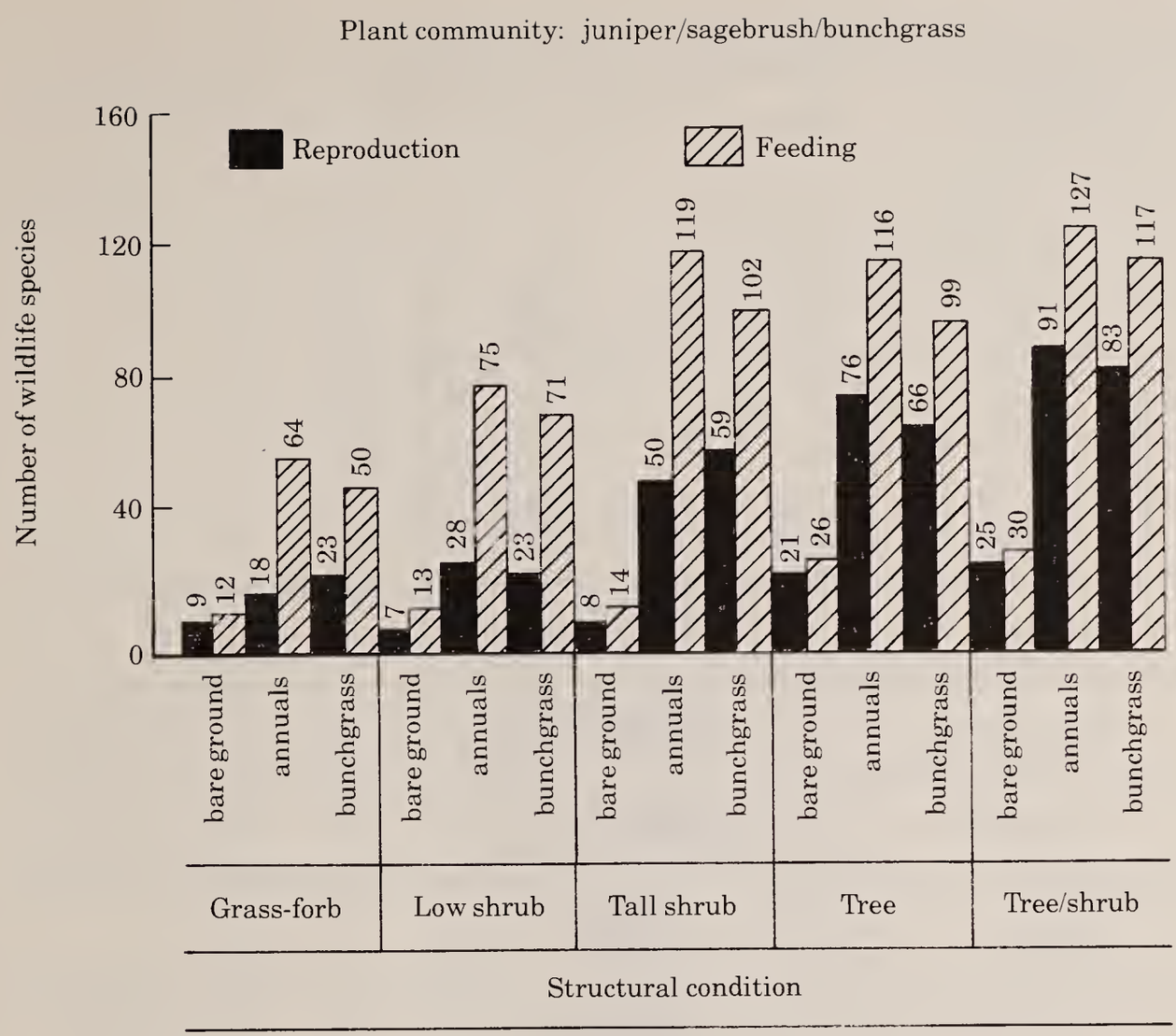


Figure 6.—Number of wildlife species associated with structural conditions in the juniper/sagebrush/bunchgrass community (source: appendix 9).

Only a few uses of such data have been illustrated. There are as many others as there are specific management questions, and new applications are being found as managers begin to use this system.

Level 3: Summary of Biological Data by Species

Level 3 is a one-line summary of key information on each species. Some of the information was derived from the appendices and some from literature reviews. Other information was drawn from the experience of wildlife biologists.

Details for each species are presented in appendix 8. Eleven species from the 29 in life form 7 are shown here as an example (table 6).

Table 6—Key information on species in life form 7 (source: appendix 8)

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
H – High

Letter code	Life form number	Species	Versatility rating	Activity/seasonal occurrence	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
BUST	7	green heron			3-6; avg. 4-5	
NYNY	7	black-crowned night heron	L		3-6	colonial nester
BUSW	7	Swainson's hawk	M		2-4	
STCAL	7	calliope hummingbird	L		2	
TYTY	7	eastern kingbird	L		3-5	aspen 3.8 ha (9.3 ac) /pr.
EMTR	7	willow flycatcher	M		3-4	
EMWR	7	gray flycatcher	M		3-4	
PIPI	7	black-billed magpie	M		6-9	
TUMI	7	American robin	M		3-5	juniper 1.9-3.4 ha/pr., aspen 2.3 ha (5.6 ac) /pr.
EUCY	7	Brewer's blackbird	M		4-6	
MOAT	7	brown-headed cowbird	M		4-6	

[1]Positive (+), negative (–), or neutral (0) net habitat associations (see chapter 13, Manmade Habitats, for fuller descriptions).

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats Riparian						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	Riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
																● ■	● ■	● ■		● ■		□	0
0.4 to 4.0 ha (1-10 ac)/ colony			■	■				○ □						● ■	● ■		● ■	● ■	■	■		□	0
nesting home range 1 pair per 6.7 km^2			□	□	□	■	■	● ■	□	■	■	● ■	■	● ■	● ■		● ■	● ■		○ □	○ □	□	+
			■	■								● ■	● ■	● ■	● ■		● ■	● ■	□	○ □	○ □	□	0
						□	□	● ■	□	■	■	● ■	● ■	● ■	● ■		● ■	● ■		○ □	○ □	□	0
breeding density: ≃0.8 ha/pr – juniper; 1.3 ha/pr – p. pine; 2.5 ha/pr – aspen					■	■	■	■	■	■	■	■	■	● ■	● ■		● ■	● ■	■	○ □	○ □	□	0
breeding density: ≃0.8 ha/pr – juniper; 1.3 ha/pr – p. pine; 2.5 ha/pr – aspen					■	■	■	● ■	■	● ■	● ■	● ■	● ■	● ■	● ■		■	■		□	□	□	0
	■	■	■	■	■	■	■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■		● ■	● ■	■	○ □	○ □	□	+
			■	■				□		■	■	■	■	● ■	● ■		● ■	● ■		○ □	○ □	□	0
	□		● ■	● ■	■	■	■	● ■	■	■	■	● ■	■	● ■	● ■		● ■	● ■		○ □	○ □	□	0
	□		● ■	● ■	■	■	■	● ■	■	■	■	● ■	■	● ■	● ■		● ■	● ■	● ■	○ □	○ □	□	0

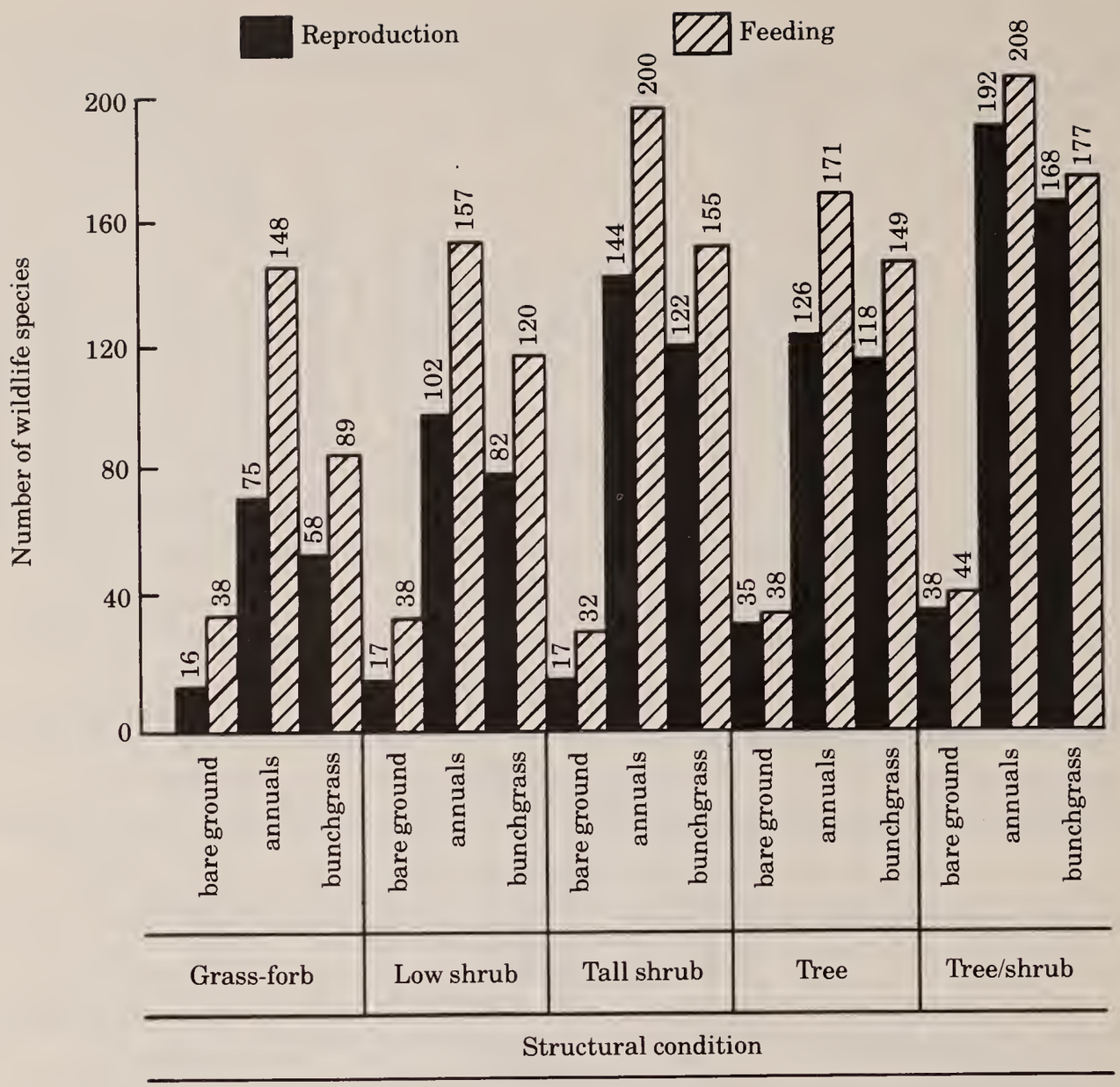


Figure 7.—Number of wildlife species oriented to desert-steppe structural conditions and the potential effect of intensive management (source: appendix 7).

Level 4: Selected References

If the information displayed so far is not sufficient, additional sources may be consulted. The most appropriate references, in our opinion, for each species are listed in appendix 10, illustrated here by table 7 for 11 species selected from life form 7. If the user, after consulting the sources suggested, still does not have sufficient information, the literature cited sections of these sources may provide useful leads.

Versatility Index

Each wildlife species exhibits a different degree of versatility (adaptability) in the number of plant communities and structural conditions it can use for feeding and reproduction. The sensitivity of each species to habitat change is directly related to that versatility. The most versatile species are the least sensitive to habitat manipulation; the least versatile are the most sensitive.

Data in appendices 6 and 7 (illustrated by tables 4 and 5) were used to develop a versatility score (V score) for each species. The V scores can be used to rate the versatility of individual species. Collectively, the scores also provide an index to the relative versatility of all resident wildlife species. Remember, the versatility index is meaningful only for the particular area and conditions for which it is derived. Do not try to make comparisons between different areas and conditions; i.e., do not compare the indices derived for the Blue Mountains of Oregon (Thomas et al. 1979) to those derived for the Great Basin of southeastern Oregon.

The V score for each species is derived by determining the total number of plant communities and the total number of structural conditions to which the species show primary orientation for feeding and reproduction:

$$V = (C_r + S_r) + (C_f + S_f);$$

where V is the versatility score, C_r is the number of communities used by the species for reproduction, S_r is the number of structural conditions used for reproduction, C_f is the number of communities used for feeding, and S_f is the number of structural conditions used for feeding.

Table 7—Selected references for species in life form 7 (source: appendix 10)

Common name	References
Green heron	Kushlan 1976
Black-crowned night heron	Allen and Mangels 1938-39, Hoffman and Prince 1975, Nickell 1966, Wolford and Boag 1971
Swainson's hawk	Dunkle 1977, Fitzner 1978, Olendorff 1972
Calliope hummingbird	Calder 1971, 1973
Eastern kingbird	Dick and Rising 1965, Hespenheide 1964, Morehouse and Brewer 1968
Willow flycatcher	Aldrich 1955, King 1955, Robbins 1974
Gray flycatcher	Johnson 1963, Lavers 1975, Russell and Woodbury 1941
Black-billed magpie	Bock and Lepthien 1975, Brown 1957, Erpino 1968, Jones 1960
American robin	Farner 1949, Henny 1972, James and Shugart 1974
Brewer's blackbird	Hansen and Carter 1963, Horn 1968, Stepney 1975, Williams 1952
Brown-headed cowbird	Friedmann 1963, Hill 1976, Payne 1976

V scores for all wildlife species in the Great Basin of southeastern Oregon are shown in appendix 11 and illustrated here by table 8. The V score for each species can be used to derive a V score for the life form as a whole as illustrated in table 9 and shown for all life forms in appendix 12. These scores reflect the versatility of species only in the Great Basin of southeastern Oregon. It is possible for a nationally common and very versatile species to have a low V score in a particular area because suitable habitat is limited.

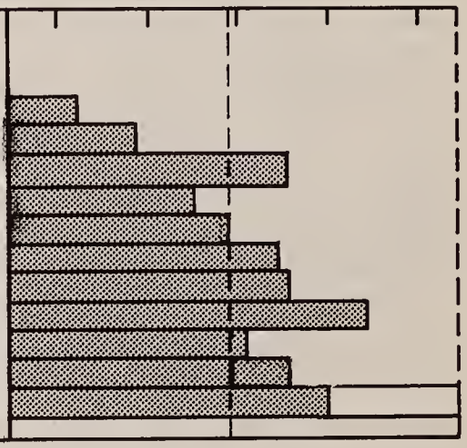
Potentially rare or threatened species are identified in appendix 13 (illustrated by table 10). These species were identified by Dyrness et al. (1975), Arbib (1978), and the U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife (1973) among others. More complete data on rare, threatened, and endangered species are given in appendix 13.

A Data Base For Planners

The informational displays presented here are a data base from which the rangeland manager may draw information at various levels. The system has been tested in preparation of land-use plans, environmental impact statements, and environmental analysis reports. It has enabled the users to produce better, more comprehensive, and more accurate results in less time.

Table 8— Versatility rating for wildlife species in life form 7 (source: appendix 11)

		Reproductive orientation			Feeding orientation			Plant community/structural condition versatility rating
Letter code	Species	No. of plant communities used (1)	No. of structural conditions used (2)	Columns 1 & 2 (3)	No. of plant communities used (4)	No. of structural conditions used (5)	Columns 4 & 5 (6)	Versatility score Columns 3 & 6 (7)
	BIRDS							
BUST	green heron	1	3	4	1	4	5	9
NYNY	black-crowned night heron	3	3	6	5	3	8	14
BUSW	Swainson's hawk	5	6	11	10	10	20	31
STCAL	calliope hummingbird	5	3	8	7	5	12	20
TYTY	eastern kingbird	6	3	9	8	7	15	24
EMTR	willow flycatcher	3	6	9	12	8	20	29
EMWR	gray flycatcher	7	6	13	12	6	18	31
PIPI	black-billed magpie	9	6	15	15	10	25	40
TUMI	American robin	3	6	9	9	8	17	26
EUCY	Brewer's blackbird	7	15	12	14	5	19	31
MOAT	brown-headed cowbird	7	7	14	14	7	21	35



The information system presented in this chapter is best suited for use in broad-scale land-use planning. The smaller the area and the greater the detail of the plan, the less likely these data are to predict results accurately. The general predictive ability should hold, but the inherent biological variability is more apt to become noticeable as size of the area diminishes.

If this information base is applied without proper interpretation, qualification, and sensitivity to individual conditions, the results will be less accurate. It is not intended to replace the trained and experienced wildlife biologist; rather, it is a tool for use by the wildlife biologist.

Table 9—Life form versatility rating for life form 7 (source: appendix 12)

Life form[1]	Number of species[2]	Range of versatility scores[3]	Mean versatility score	Life form versatility rating[4] (median scale)
7	29	9 to 40 (29)	24.5	High

[1] See table 1 for life form descriptions.
[2] The total number of species in life form.
[3] Refers to the range of versatility scores for the lowest scoring species to the highest scoring species within the life form.
[4] Versatility ratings: "low" = 12.0-17.6, "medium" = 17.7-23.4, "high" = 23.5-29.0.

Table 10—Some species in southeastern Oregon are of special interest because of their potentially threatened or endangered status (source: appendix 13)

		Species	1	2	3	4	5	6	7	8
CRCO	4	collared lizard					X			
CRVI	5	western rattlesnake				SI	X			
NYNY	7	black-crowned night heron						X		
BOLE	3	American bittern				SI		X		
SOPR	16	Malheur shrew				R	R			
VUMA	15	kit fox		T	T	T	E			
Letter code	Life form	E – Endangered P – Peripheral R – Rare SI – Species of special interest SU – Status undetermined T – Threatened U – Unique X – Occurs on list	Federal register (endangered)	Oregon State (endangered or threatened)	U.S. Dep. Inter. Fish & Wildl. Serv. "Red Book"	USDA FS RNA "Yellow Book"	OSU endangered plants and animals of Oregon	Audubon – Blue list for 1979		
			1	2	3	4	5	6	7	8
				(a)[1]			(a,b,c)[1]			

[1] The following references were used, respectively, as sources for the 6 status classification columns.

1 U.S. Fish and Wildlife Service (1979)
2a Oregon Department of Fish and Wildlife (1977)
2b Shay (1973)
3 U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife (1973)
4 Dyrness et al. (1975)
5a Storm (1966)
5b Marshall (1969)
5c Olterman and Verts (1972)
6 Arbib (1978)

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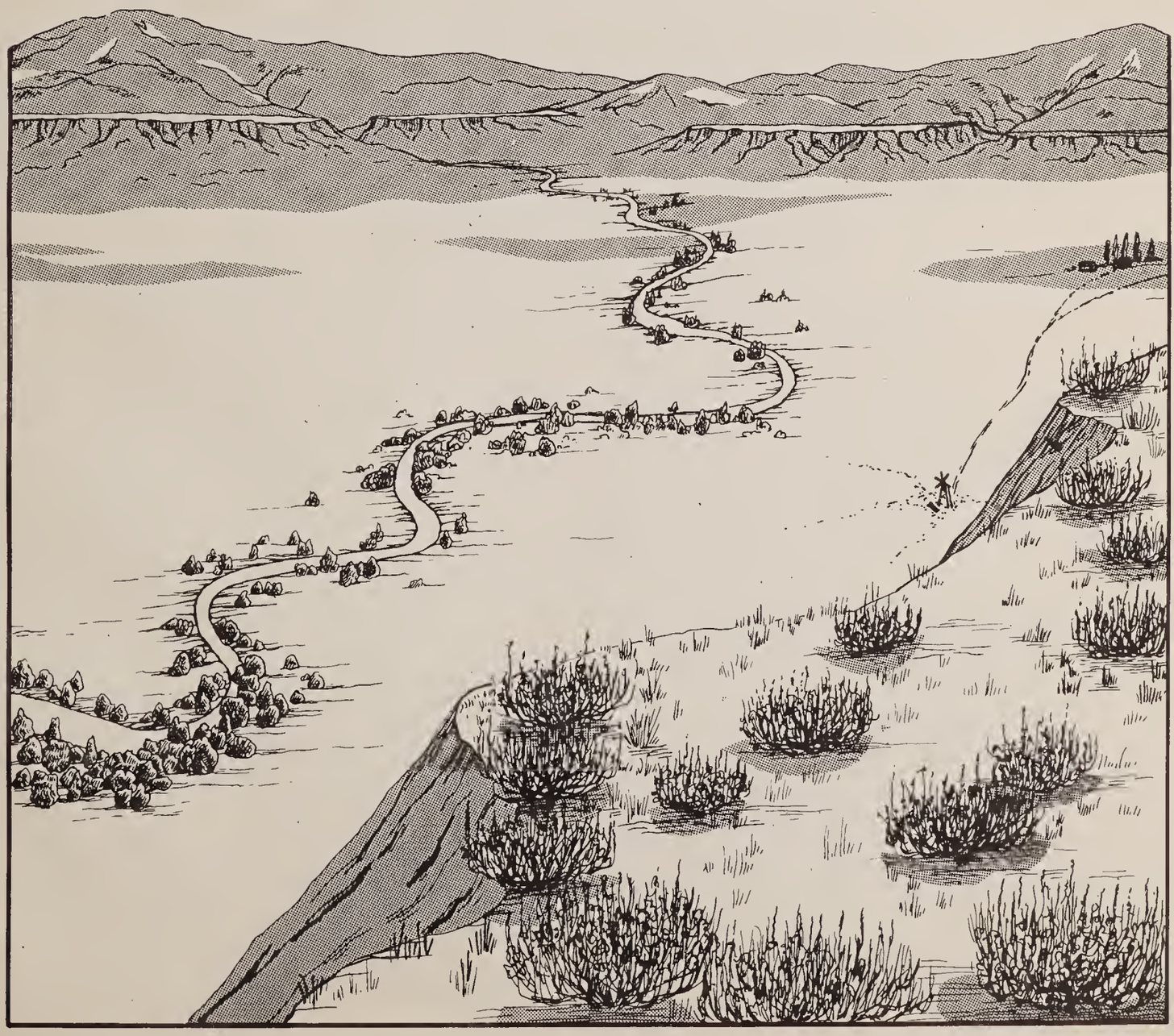
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

The Relationship of Terrestrial Vertebrates to Plant Communities, Part 2, Appendices

Chris Maser, Jack Ward Thomas, and Ralph G. Anderson



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ABSTRACT

The relationships of terrestrial vertebrates to plant communities, structural conditions, and special habitats in the Great Basin of southeastern Oregon are described in a series of appendices. The importance of habitat components to wildlife and the predictability of management activities on wildlife are examined in terms of managed rangelands. The derivation and use of these appendices are described in a companion publication, General Technical Report PNW-172, Part 1.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

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Introduction

The appendices that follow provide the data base information to consider wildlife habitat relationships in that portion of the Great Basin that lies in southeastern Oregon. The details on how this information was derived and how it may be used to analyze impacts of land management decisions on terrestrial vertebrates are given in:

> Maser, Chris; Thomas, Jack Ward; Anderson, Ralph G. Wildlife habitats in managed rangelands—the Great Basin of southeastern Oregon: the relationships of terrestrial vertebrates to plant communities and structural conditions. Gen. Tech. Rep. PNW-172, part 1 of 2 parts. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1984. 25 p.

These appendices are published separately as they are apt to be of interest primarily to those applying the wildlife habitat relationships system to the particular geographical area described. The text (part 1, referenced above) discusses the principles and procedures concerning the development and application of wildlife habitat relationships that are of a more general interest.

Appendix 1. 341 wildlife species of southeast Oregon listed phylogenetically by common and scientific names.

Letter code	Life form	Common name	Scientific name
		AMPHIBIANS	
AMMA	2	long-toed salamander	*Ambystoma macrodactylum*
SCIN	2	Great Basin spadefoot	*Scaphiopus intermontanus*
BUBO	2	western toad	*Bufo boreas*
BUWO	2	Woodhouse toad	*Bufo woodhousei*
HYRE	2	Pacific treefrog	*Hyla regilla*
RAPR	1	spotted frog	*Rana pretiosa*
RAPI	2	leopard frog	*Rana pipiens*
RACA	1	bullfrog	*Rana catesbiana*
		REPTILES	
CRCO	4	collared lizard	*Crotaphytus collaris*
CRWI	5	leopard lizard	*Crotaphytus wislizeni*
SCOC	4	western fence lizard	*Sceloporus occidentalis*
SCGR	5	sagebrush lizard	*Sceloporus graciosus*
UTST	5	side-blotched lizard	*Uta stansburiana*
PHPL	5	desert horned lizard	*Phrynosoma platyrhinos*
PHDO	5	short-horned lizard	*Phrynosoma douglassi*
EUSK	5	western skink	*Eumeces skiltonianus*
CNTI	5	western whiptail	*Cnemidophorus tigris*
CHBO	5	rubber boa	*Charina bottae*
COCONS	5	yellow-bellied racer	*Coluber constrictor*
MATA	5	striped whipsnake	*Masticophis taeniatus*
PIME	5	gopher snake	*Pituophis melanoleucus*
THSI	3	common garter snake	*Thamnophis sirtalis*
THEL	3	wandering garter snake	*Thamnophis elegans*
SOSE	15	western ground snake	*Sonora semiannulata*
HYTO	5	night snake	*Hypsiglena torquata*
CRVI	5	western rattlesnake	*Crotalus viridis*

Letter code	Life form	Common name	Scientific name
		BIRDS	
GAIM	3	common loon	*Gavia immer*
POGRI	3	red-necked grebe	*Podiceps grisegena*
POAU	3	horned grebe	*Podiceps auritus*
PONIGR	3	eared grebe	*Podiceps nigricollis*
AEOC	3	western grebe	*Aechmophorus occidentalis*
POPO	3	pied-billed grebe	*Podilymbus podiceps*
PEERY	3	American white pelican	*Pelecanus erythrorhynchos*
PHAU	3	double-crested cormorant	*Phalacrocorax auritus*
ARHE	12	great blue heron	*Ardea herodias*
BUST	7	green heron	*Butorides striatus*
CAAL	12	common egret	*Casmerodius albus*
BUIB	7	cattle egret	*Bubuculus ibis*
NYNY	7	black-crowned night heron	*Nycticorax nycticorax*
BOLE	3	American bittern	*Botaurus lentiginosus*
IXEX	3	least bittern	*Ixobrychus exilis*
PLCH	7	white-faced ibis	*Plegadis chihi*
OLCO	3	whistling swan	*Olor columbianus*
BRCA	3	Canada goose	*Branta canadensis*
BRCALE	3	Aleutian Canada goose	*Branta canadensis leucopareia*
ANAL	3	greater white-fronted goose	*Anser albifrons*
ANALGA	3	Tule white-fronted goose	*Anser albifrons gambelli*
CHCA	3	snow goose	*Chen caerulescens*
CHRO	3	Ross' goose	*Chen rossii*
ANPL	3	mallard	*Anas platyrhynchos*
ANSTR	3	gadwall	*Anas strepera*
ANAC	3	common pintail	*Anas acuta*
ANCR	3	green-winged teal	*Anas crecca*
ANDIS	3	blue-winged teal	*Anas discors*
ANCY	3	cinnamon teal	*Anas cyanoptera*
ANAMEO	3	American wigeon	*Anas americana*
ANCL	3	northern shoveler	*Anas clypeata*
AISP	14	wood duck	*Aix sponsa*
AYAM	3	redhead	*Aythya americana*
AYCO	3	ring-necked duck	*Aythya collaris*
AYVA	3	canvasback	*Aythya valisineria*
AYMA	3	greater scaup	*Aythya marila*
AYAF	3	lesser scaup	*Aythya affinis*
BUCL	3	common goldeneye	*Bucephala clangula*
BUIS	14	Barrow's goldeneye	*Bucephala islandica*
BUALBE	14	bufflehead	*Bucephala albeola*
SOSP	3	king eider	*Somateria spectabilis*
CLHY	3	oldsquaw	*Clangula hyemalis*
OXJA	3	ruddy duck	*Oxyura jamaicensis*
LOCU	14	hooded merganser	*Lophodytes cucullatus*
MEMER	14	common merganser	*Mergus merganser*
MESE	3	red-breasted merganser	*Mergus serrator*
CAAU	4	turkey vulture	*Cathartes aura*
ACGE	11	northern goshawk	*Accipiter gentilis*
ACST	11	sharp-shinned hawk	*Accipiter striatus*
ACCO	11	Cooper's hawk	*Accipiter cooperii*
BUJA	12	red-tailed hawk	*Buteo jamaicensis*
BUSW	7	Swainson's hawk	*Buteo swainsoni*
BULA	4	rough-legged hawk	*Buteo lagopus*
BUREG	4	ferruginous hawk	*Buteo regalis*
AQCH	12	golden eagle	*Aquila chrysaetos*
HALE	12	bald eagle	*Haliaeetus leucocephalus*
CICY	5	northern harrier	*Circus cyaneus*
PAHA	12	osprey	*Pandion haliaetus*
FAME	4	prairie falcon	*Falco mexicanus*
FAPE	4	peregrine	*Falco peregrinus*
FACO	11	merlin	*Falco columbarius*
FASP	14	American kestrel	*Falco sparverius*
DEOB	5	blue grouse	*Dendragapus obscurus*
BOUM	5	ruffed grouse	*Bonasa umbellus*
CEUR	5	sage grouse	*Centrocercus urophasianus*
LOCA	5	California quail	*Lophortyx californicus*
ORPI	5	mountain quail	*Oreortyx pictus*
ALCH	4	chukar	*Alectoris chukar*
PEPER	5	grey partridge	*Perdix perdix*
PHCOL	5	ring-necked pheasant	*Phasianus colchicus*
GRCA	3	sandhill crane	*Grus canadensis*

Letter code	Life form	Common name	Scientific name
RALI	3	Virginia rail	*Rallus limicola*
POCAR	3	sora	*Porzana carolina*
FUAM	3	American coot	*Fulica americana*
CHSEM	3	semipalmated plover	*Charadrius semipalmatus*
CHALE	3	snowy plover	*Charadrius alexandrinus*
CHVO	3	killdeer	*Charadrius vociferus*
CHMO	3	mountain plover	*Charadrius montanus*
CAGA	3	common snipe	*Capella gallinago*
NUAM	3	long-billed curlew	*Numenius americanus*
ACMA	3	spotted sandpiper	*Actitis macularia*
TRSO	7	solitary sandpiper	*Tringa solitaria*
TRME	3	greater yellowlegs	*Tringa melanoleuca*
TRFL	3	lesser yellowlegs	*Tringa flavipes*
CASE	3	willet	*Catoptrophorus semipalmatus*
CAMEL	3	pectoral sandpiper	*Calidris melanotos*
CABA	3	Baird's sandpiper	*Calidris bairdii*
CAMI	3	least sandpiper	*Calidris minutilla*
CAMAU	3	western sandpiper	*Calidris mauri*
LISC	3	long-billed dowitcher	*Limodromus scolopaceus*
LIFE	3	marbled godwit	*Limosa fedoa*
REAM	3	American avocet	*Recurvirostra americana*
HIME	3	black-necked stilt	*Himantopus mexicanus*
STTRI	3	Wilson's phalarope	*Steganopus tricolor*
LOLO	3	nothern phalarope	*Lobipes lobatus*
LAAR	3	herring gull	*Larus argentatus*
LACA	3	California gull	*Larus californicus*
LADE	3	ring-billed gull	*Larus delawarensis*
LAPI	3	Franklin's gull	*Larus pipixcan*
LAPH	3	Bonaparte's gull	*Larus philadelphia*
STFO	3	Forster's tern	*Sterna forsteri*
STCAS	3	Caspian tern	*Sterna caspia*
CHNI	3	black tern	*Chlidonias niger*
COLI	4	rockdove	*Columba livia*
ZEMA	11	mourning dove	*Zenaida macroura*
COAM	8	yellow-billed cuckoo	*Coccyzus americanus*
TYAL	14	barn owl	*Tyto alba*

Letter code	Life form	Common name	Scientific name
OTAS	14	common screech owl	*Otus asio*
OTFL	14	flammulated owl	*Otus flammeolus*
BUVIR	12	great horned owl	*Bubo virginianus*
GLGN	14	pygmy owl	*Glaucidium gnoma*
ATCU	15	burrowing owl	*Athene cunicularia*
ASOT	11	long-eared owl	*Asio otus*
ASFL	5	short-eared owl	*Asio flammeus*
AEAC	14	saw-whet owl	*Aegolius acadicus*
PHNU	6	poorwill	*Phalaenoptilus nuttalli*
CHMI	6	common nighthawk	*Chordeiles minor*
CYNI	4	black swift	*Cypseloides niger*
CHVA	14	Vaux's swift	*Chaetura vauxi*
AESA	4	white-throated swift	*Aeronautes saxatalis*
ARAL	7	black-chinned hummingbird	*Archilochus alexandri*
SEPL	7	broad-tailed hummingbird	*Selasphorus platycercus*
SERUF	11	rufous hummingbird	*Selasphorus rufus*
STCAL	7	calliope hummingbird	*Stellula calliope*
CAAN	7	Anna's hummingbird	*Calypte anna*
MEAL	16	belted kingfisher	*Megaceryle alcyon*
COAU	13	common flicker	*Colaptes auratus*
MELE	13	Lewis' woodpecker	*Melanerpes lewis*
SPVAR	13	yellow-bellied sapsucker	*Sphyrapicus varius*
SPTH	13	Williamson's sapsucker	*Sphyrapicus thyroideus*
PIVI	13	hairy woodpecker	*Picoides villosus*
PIPU	13	downy woodpecker	*Picoides pubescens*
PIAL	13	white-headed woodpecker	*Picoides albolarvatus*
TYTY	7	eastern kingbird	*Tyrannus tyrannus*
TYVE	11	western kingbird	*Tyrannus verticalis*
MYCI	14	ash-throated flycatcher	*Myiarchus cinerascens*
SASA	4	Say's phoebe	*Sayornis saya*
EMTR	7	willow flycatcher	*Empidonax traillii*
EMHA	11	Hammond's flycatcher	*Empidonax hammondii*

Letter code	Life form	Common name	Scientific name
EMWR	7	gray flycatcher	*Empidonax wrightii*
EMDI	10	western flycatcher	*Empidonax difficilis*
COSO	11	western wood pewee	*Contopus sordidulus*
NUBO	10	olive-sided flycatcher	*Nuttallornis borealis*
ERAL	5	horned lark	*Eremophila alpestris*
TATH	14	violet-green swallow	*Tachycineta thalassina*
IRBI	14	tree swallow	*Iridoprocne bicolor*
RIRI	16	bankswallow	*Riparia riparia*
STRU	16	rough-winged swallow	*Stelgidopteryx ruficollis*
HIRU	4	barn swallow	*Hirundo rustica*
PEPY	4	cliff swallow	*Petrochelidon pyrrhonota*
PECA	11	gray jay	*Perisoreus canadensis*
CYST	11	Steller's jay	*Cyanocitta stelleri*
APCO	7	scrub jay	*Aphelocoma coerulescens*
PIPI	7	black-billed magpie	*Pica pica*
COCOR	4	northern raven	*Corvus corax*
COBRA	11	American crow	*Corvus brachyrhynchos*
GYCY	10	pinyon jay	*Gymnorhinus cyanocephalus*
NUCO	10	Clark's nutcracker	*Nucifraga columbiana*
PAATR	14	black-capped chickadee	*Parus atricapillus*
PAGA	14	mountain chickadee	*Parus gambeli*
PSMI	8	bushtit	*Psaltriparus minimus*
SICAR	13	white-breasted nuthatch	*Sitta carolinensis*
SICAN	13	red-breasted nuthatch	*Sitta canadensis*
CEFA	14	brown creeper	*Certhia familiaris*
CIME	3	dipper	*Cinclus mexicanus*
TRAE	14	house wren	*Troglodytes aedon*
TRTR	3	winter wren	*Troglodytes troglodytes*
CIPA	3	marsh wren	*Cistophorus palustris*

Letter code	Life form	Common name	Scientific name
CAMEXO	4	canyon wren	*Catherpes mexicanus*
SAOB	4	rock wren	*Salpinctes obsoletus*
MIPO	7	northern mockingbird	*Mimus polyglottos*
DUCA	7	gray catbird	*Dumetella carolinensis*
TORU	7	brown thrasher	*Toxostoma rufum*
ORMO	7	sage thrasher	*Oreoscoptes montanus*
TUMI	7	American robin	*Turdus migratorius*
IXNA	11	varied thrush	*Ixoreus naevius*
CAGU	5	hermit thrush	*Catharus guttatus*
CAUS	7	Swainson's thrush	*Catharus ustulatus*
CAFU	5	veery	*Catharus fuscescens*
SIME	14	western bluebird	*Sialia mexicana*
SICU	14	mountain bluebird	*Sialia currucoides*
MYTO	6	Townsend's solitaire	*Myadestes townsendi*
POCAE	7	blue-gray gnatcatcher	*Polioptila caerulea*
RESA	10	golden-crowned kinglet	*Regulus satrapa*
RECA	10	ruby-crowned kinglet	*Regulus calendula*
ANSP	5	water pipit	*Anthus spinoletta*
BOGA	9	Bohemian waxwing	*Bombycilla garrulus*
BOCE	9	cedar waxwing	*Bombycilla cedrorum*
LAEX	7	northern shrike	*Lanius excubitor*
LALU	7	loggerhead shrike	*Lanius ludovicianus*
STVU	14	European starling	*Sturnus vulgaris*
VISO	11	solitary vireo	*Vireo solitarius*
VIOL	11	red-eyed vireo	*Vireo olivaceus*
VIGI	11	warbling vireo	*Vireo gilvus*
VECE	6	orange-crowned warbler	*Vermivora celata*
DEPE	8	yellow warbler	*Dendroica petechia*
DECOR	10	yellow-rumped warbler	*Dendroica coronata*
DENI	10	black-throated grey warbler	*Dendroica nigrescens*

Letter code	Life form	Common name	Scientific name
DETO	10	Townsend's warbler	*Dendroica townsendi*
OPTO	7	MacGillivray's warbler	*Oporornis tolmiei*
GETR	3	common yellowthroat	*Geothlypis trichas*
ICVI	8	yellow-breasted chat	*Icteria virens*
SEAU	7	ovenbird	*Seiurus aurocapillus*
WIPU	5	Wilson's warbler	*Wilsonia pusilla*
SERUT	9	American redstart	*Setophaga ruticilla*
PADO	14	house sparrow	*Passer domesticus*
DOOR	5	bobolink	*Dolichonyx oryzivorus*
STNEG	5	western meadowlark	*Sturnella neglecta*
XAXA	7	yellow-headed blackbird	*Xanthocephalus xanthocephalus*
AGPH	7	red-winged blackbird	*Agelaius phoeniceus*
ICGA	9	northern oriole	*Icterus galbula*
EUCY	7	Brewer's blackbird	*Euphagus cyanocephalus*
MOAT	7	brown-headed cowbird	*Molothrus ater*
PILU	10	western tanager	*Piranga ludoviciana*
PHLU	9	rose-breasted grosbeak	*Pheucticus ludovicianus*
PHME	11	black-headed grosbeak	*Pheucticus melanocephalus*
PACY	8	indigo bunting	*Passerina cyanea*
PAAMO	7	lazuli bunting	*Passerina amoena*
HEVE	11	evening grosbeak	*Hesperiphona vespertina*
CAPU	11	purple finch	*Carpodacus purpureus*
CACUS	11	Cassin's finch	*Carpodacus cassinii*
CAMEXI	9	house finch	*Carpodacus mexicanus*
LEAT	4	black rosy finch	*Leucosticte atrata*
CAFL	9	common redpoll	*Carduelis flammea*
CAPI	11	pine siskin	*Carduelis pinus*
CATR	8	American goldfinch	*Carduelis tristis*
CAPS	7	lesser goldfinch	*Carduelis psaltria*

Letter code	Life form	Common name	Scientific name
PICH	7	green-tailed towhee	*Pipilo chlorura*
PIER	7	rufous-sided towhee	*Pipilo erythrophthalmus*
PASA	5	savannah sparrow	*Passerculus sandwichensis*
AMSA	5	grasshopper sparrow	*Ammodramus savannarum*
POGRA	5	vesper sparrow	*Pooecetes gramineus*
CHGR	5	lark sparrow	*Chondestes grammacus*
AMBI	7	black-throated sparrow	*Amphispiza bilineata*
AMBE	7	sage sparrow	*Amphispiza belli*
JUHY	5	northern junco	*Junco hyemalis*
SPARB	11	American tree sparrow	*Spizella arborea*
SPPA	7	chipping sparrow	*Spizella passerina*
SPBRE	7	Brewer's sparrow	*Spizella breweri*
ZOLE	7	white-crowned sparrow	*Zonotrichia leucophrys*
ZOAT	7	golden-crowned sparrow	*Zonotrichia atricapilla*
PAIL	7	fox sparrow	*Passerella iliaca*
MELI	6	Lincoln's sparrow	*Melospiza lincolnii*
MEMEL	7	song sparrow	*Melospiza melodia*
CALA	5	Lapland longspur	*Calcarius lapponicus*
PLNI	5	snow bunting	*Plectophenax nivalis*
		MAMMALS	
SOPR	16	Malheur shrew	*Sorex preblei*
SOVA	16	wandering shrew	*Sorex vagrans*
SOME	15	Merriam shrew	*Sorex merriami*
MYLU	4	little brown myotis	*Myotis lucifugus*
MYYU	14	Yuma myotis	*Myotis yumanensis*
MYEV	14	long-eared myotis	*Myotis evotis*
MYTH	4	fringed myotis	*Myotis thysanodes*
MYVO	14	long-legged myotis	*Myotis volans*
MYCA	4	California myotis	*Myotis californicus*
MYLE	4	small-footed myotis	*Myotis leibi*

Letter code	Life form	Common name	Scientific name
LANO	14	silver-haired bat	*Lasionycteris noctivagans*
PIHE	4	western pipistrelle	*Pipistrellus hesperus*
EPFU	4	big brown bat	*Eptesicus fuscus*
LACI	9	hoary bat	*Lasiurus cinereus*
EUMAC	4	spotted bat	*Euderma maculatum*
PLTO	4	western big-eared bat	*Plecotus townsendi*
ANPA	4	pallid bat	*Antrozous pallidus*
SYID	5	pygmy rabbit	*Sylvilagus idahoensis*
SYNU	5	mountain cottontail	*Sylvilagus nuttalli*
LETO	5	white-tailed jackrabbit	*Lepus townsendi*
LECA	5	black-tailed jackrabbit	*Lepus californicus*
EUMI	15	least chipmunk	*Eutamias minimus*
EUAM	15	yellow pine chipmunk	*Eutamias amoenus*
MAFL	4	yellow-bellied marmot	*Marmota flaviventris*
AMLE	15	antelope ground squirrel	*Ammospermophilus leucurus*
SPTO	15	Townsend ground squirrel	*Spermophilus townsendi*
SPRI	15	Richardson ground squirrel	*Spermophilus richardsoni*
SPBE	15	Belding ground squirrel	*Spermophilus beldingi*
SPCO	15	Columbian ground squirrel	*Spermophilus columbianus*
SPLA	15	mantled ground squirrel	*Spermophilus lateralis*
THTO	15	Townsend pocket gopher	*Thomomys townsendi*
THTA	15	northern pocket gopher	*Thomomys talpoides*
PELO	15	little pocket mouse	*Perognathus longimembris*
PEPA	15	Great Basin pocket mouse	*Perognathus parvus*
MIME	15	dark kangaroo mouse	*Microdipodops megacephalus*
DIOR	15	Ord kangaroo rat	*Dipodomys ordi*
DIMI	15	chisel-toothed kangaroo rat	*Dipodomys microps*
CACAN	16	beaver	*Castor canadensis*
REME	15	western harvest mouse	*Reithrodontomys megalotis*
PECR	4	canyon mouse	*Peromyscus crinitus*
PEMA	15	deer mouse	*Peromyscus maniculatus*
ONLE	15	northern grasshopper mouse	*Onychomys leucogastor*
NELE	4	desert woodrat	*Neotoma lepida*
NECI	4	bushy-tailed woodrat	*Neotoma cinerea*
MIMO	15	montane vole	*Microtus montanus*
MILO	15	long-tailed vole	*Microtus longicaudus*
LACU	15	sage vole	*Lagurus curtatus*
ONZI	16	muskrat	*Ondatra zibethicus*
RARA	5	black rat	*Rattus rattus*
RANO	5	Norway rat	*Rattus norvegicus*
ZAPR	15	western jumping mouse	*Zapus princeps*
ERDO	4	porcupine	*Erethizon dorsatum*
CALAT	15	coyote	*Canis latrans*
VUVU	15	red fox	*Vulpes vulpes*
VUMA	15	kit fox	*Vulpes macrotis*
PRLO	14	raccoon	*Procyon lotor*
MUER	15	short-tailed weasel	*Mustela erminea*
MUFR	15	long-tailed weasel	*Mustela frenata*
MUVI	16	mink	*Mustela vison*
TATA	15	badger	*Taxidea taxus*
SPPU	4	spotted skunk	*Spilogale putorius*
MEMEP	15	stripped skunk	*Mephitis mephitis*
LUCA	16	river otter	*Lutra canadensis*
FECO	4	puma	*Felis concolor*
FECA	5	feral house cat	*Felis catus*
LYRU	4	bobcat	*Lynx rufus*
EQCA	5	feral horse	*Equus cabalus*
CEEL	5	elk	*Cervus elaphus*
ODHE	5	mule deer	*Odocoileus hemionus*
ANAMER	5	pronghorn	*Antilocapra americana*
OVCA	5	bighorn sheep	*Ovis canadensis*

Appendix 2. Alphabetical computer codes for 341 wildlife species in southeast Oregon.

Letter code	Life form	Scientific name	Common name
ACCO	11	*Accipiter cooperii*	Cooper's hawk
ACGE	11	*Accipiter gentilis*	northern goshawk
ACMA	3	*Actitis macularia*	spotted sandpiper
ACST	11	*Accipiter striatus*	sharp-shinned hawk
AEAC	14	*Aegolius acadicus*	saw-whet owl
AEOC	3	*Aechmophorus occidentalis*	western grebe
AESA	4	*Aeronautes saxitalis*	white-throated swift
AGPH	7	*Agelaius phoeniceus*	red-winged blackbird
AISP	14	*Aix sponsa*	wood duck
ALCH	4	*Alectoris chukar*	chukar
AMBE	7	*Amphispiza belli*	sage sparrow
AMBI	7	*Amphispiza bilineata*	black-throated sparrow
AMLE	15	*Ammospermophilus leucurus*	antelope ground squirrel
AMMA	2	*Ambystoma macrodactylum*	long-toed salamander
AMSA	5	*Ammodramus savannarum*	grasshopper sparrow
ANAC	3	*Anas acuta*	common pintail
ANAL	3	*Anser albifrons*	greater white-fronted goose
ANALGA	3	*Anser albifrons gambelli*	Tule white-fronted goose
ANAMEO	3	*Anas americana*	American wigeon
ANAMER	5	*Antilocapra americana*	pronghorn
ANCL	3	*Anas clypeata*	northern shoveler
ANCR	3	*Anas crecca*	green-winged teal
ANCY	3	*Anas cyanoptera*	cinnamon teal
ANDIS	3	*Anas discors*	blue-winged teal
ANPA	4	*Antrozous pallidus*	pallid bat
ANPL	3	*Anas platyrhynchos*	mallard
ANSP	5	*Anthus spinoletta*	water pipit
ANSTR	3	*Anas strepera*	gadwall
APCO	7	*Aphelocoma coerulescens*	scrub jay
AQCH	12	*Aquila chrysaetos*	golden eagle
ARAL	7	*Archilochus alexandri*	black-chinned hummingbird
ARHE	12	*Ardea herodias*	great blue heron
ASFL	15	*Asio flammeus*	short-eared owl
ASOT	11	*Asio otus*	long-eared owl
ATCU	15	*Athene cunicularia*	burrowing owl
AYAF	3	*Aythya affinis*	lesser scaup
AYAM	3	*Aythya americana*	redhead
AYCO	3	*Aythya collaris*	ring-necked duck
AYMA	3	*Aythya marila*	greater scaup
AYVA	3	*Aythya valisineria*	canvasback
BOCE	9	*Bombycilla cedrorum*	cedar waxwing
BOGA	9	*Bombycilla garrulus*	Bohemian waxwing
BOLE	3	*Botaurus lentiginosus*	American bittern
BOUM	5	*Bonasa umbellus*	ruffed grouse
BRCA	3	*Branta canadensis*	Canada goose
BRCALE	3	*Branta canadensis gambelli*	Aleutian Canada goose
BUALBE	14	*Bucephala albeola*	bufflehead
BUBO	2	*Bufo boreas*	western toad
BUCL	3	*Bucephala clangula*	common goldeneye
BUIB	7	*Bubuculus ibis*	cattle egret
BUIS	14	*Bucephala islandica*	Barrow's goldeneye
BUJA	12	*Buteo jamaicensis*	red-tailed hawk
BULA	4	*Buteo lagopus*	rough-legged hawk
BUREG	4	*Buteo regalis*	ferruginous hawk
BUST	7	*Butorides striatus*	green heron
BUSW	7	*Buteo swainsoni*	Swainson's hawk
BUVIR	12	*Bubo virginianus*	great horned owl
BUWO	2	*Bufo woodhousei*	Woodhouse toad
CAAL	12	*Casmerodius albus*	common egret
CAAN	7	*Calypte anna*	Anna's hummingbird
CAAU	4	*Cathartes aura*	turkey vulture
CABA	3	*Calidris bairdii*	Baird's sandpiper
CACAN	16	*Castor canadensis*	beaver
CACAS	11	*Carpodacus cassinii*	Cassin's finch
CAFL	9	*Carduelis flammea*	common redpoll
CAFU	5	*Catharus fuscescens*	veery
CAGA	3	*Capella gallinago*	common snipe
CAGU	5	*Catharus guttatus*	hermit thrush
CALA	5	*Calcarius lapponicus*	Lapland longspur

Letter code	Life form	Scientific name	Common name
CALAT	15	*Canis latrans*	coyote
CAMAU	3	*Calidris mauri*	western sandpiper
CAMEL	3	*Calidris melanots*	pectoral sandpiper
CAMEXO	4	*Catherpes mexicanus*	canyon wren
CAMEXI	9	*Carpodacus mexicanus*	house finch
CAMI	3	*Calidris minutilla*	least sandpiper
CAPI	11	*Carduelis pinus*	pine siskin
CAPS	7	*Carduelis psaltria*	lesser goldfinch
CAPU	11	*Carpodacus purpureus*	purple finch
CASE	3	*Catoptrophorus semipalmatus*	willet
CATR	8	*Carduelis tristis*	American goldfinch
CAUS	7	*Catharus ustulatus*	Swainson's thrush
CEEL	5	*Cervus elaphus*	elk
CEFA	14	*Certhia familiaris*	brown creeper
CEUR	5	*Centrocercus urophasianus*	sage grouse
CHALE	3	*Charadrius alexandrius*	snowy plover
CHBO	5	*Charina bottae*	rubber boa
CHCA	3	*Chen caerulescens*	snow goose
CHGR	5	*Chondestes grammacus*	lark sparrow
CHMI	6	*Chordeiles minor*	common nighthawk
CHMO	3	*Charadrius montanus*	mountain plover
CHNI	3	*Chlidonias niger*	black tern
CHRO	3	*Chen rossii*	Ross' goose
CHSEM	3	*Charadrius semipalmatus*	semipalmated plover
CHVA	14	*Chaetura vauxi*	Vaux's swift
CHVO	3	*Charadrius vociferus*	killdeer
CICY	5	*Circus cyaneus*	northern harrier
CIME	3	*Cinclus mexicanus*	dipper
CIPA	3	*Cistophorus palustris*	marsh wren
CLHY	3	*Clangula hyemalis*	oldsquaw
CNTI	5	*Cnemidophorus tigris*	western whiptail
COAM	8	*Coccyzus americanus*	yellow-billed cuckoo
COAU	13	*Colaptes auratus*	common flicker
COBRA	11	*Corvus brachyrhynchos*	American crow
COCONS	5	*Coluber constrictor*	yellow-bellied racer
COCOR	4	*Corvus corax*	northern raven
COLI	4	*Columba livia*	rock dove
COSO	11	*Contopus sordidulus*	western wood pewee
CRCO	4	*Crotaphytus collaris*	collared lizard
CRVI	5	*Crotalis viridis*	western rattlesnake
CRWI	5	*Crotaphytus wislizeni*	leopard lizard
CYNI	4	*Cypseloides niger*	black swift
CYST	11	*Cyanocitta stelleri*	Steller's jay
DECOR	10	*Dendroica coronata*	yellow-rumped warbler
DENI	10	*Dendroica nigrescens*	black-throated grey warbler
DEOB	5	*Dendragapus obscurus*	blue grouse
DEPE	8	*Dendroica petechia*	yellow warbler
DETO	10	*Dendroica townsendi*	Townsend's warbler
DIMI	15	*Dipodomys microps*	chisel-toothed kangaroo rat
DIOR	15	*Dipodomys ordi*	Ord kangaroo rat
DOOR	5	*Dolichonyx oryzivorus*	bobolink
DUCA	7	*Dumetella carolinensis*	gray catbird
EMDI	10	*Empidonax difficilis*	western flycatcher
EMHA	11	*Empidonax hammondii*	Hammond's flycatcher
EMTR	7	*Empidonax traillii*	willow flycatcher
EMWR	7	*Empidonax wrightii*	gray flycatcher
EPFU	4	*Eptesicus fuscus*	big brown bat
EQCA	5	*Equus cabalus*	feral horse
ERAL	5	*Eremophila alpestris*	horned lark
ERDO	4	*Erethizon dorsatum*	porcupine
EUAM	15	*Eutamias amoenus*	yellow pine chipmunk
EUCY	7	*Euphagus cyanocephalus*	Brewer's blackbird

Letter code	Life form	Scientific name	Common name
EUMA	4	*Euderma maculatum*	spotted bat
EUMI	15	*Eutamias minimus*	least chipmunk
EUSK	5	*Eumeces skiltonianus*	western skink
FACO	11	*Falco columbarius*	merlin
FAME	4	*Falco mexicanus*	prairie falcon
FAPE	4	*Falco peregrinus*	peregrine falcon
FASP	14	*Falco sparverius*	American kestrel
FECA	5	*Felis catus*	feral house cat
FECO	4	*Felis concolor*	puma
FUAM	3	*Fulica ameriana*	American coot
GAIM	3	*Gavia immer*	common loon
GETR	3	*Geothlypis trichas*	common yellowthroat
GLGN	14	*Glaucidium gnoma*	pygmy owl
GRCA	3	*Grus canadensis*	sandhill crane
GYCY	10	*Gymnorhinus cyanocephalus*	pinyon jay
HALE	12	*Haliaeetus leucocephalus*	baldeagle
HEVE	11	*Hesperiphona vespertina*	evening grosbeak
HIME	3	*Himantopus mexicanus*	black-necked stilt
HIRU	4	*Hirundo rustica*	barn swallow
HYRE	2	*Hyla regilla*	Pacific treefrog
HYTO	5	*Hypsiglena torquata*	night snake
ICGA	9	*Icterus galbula*	northern oriole
ICVI	8	*Icteria virens*	yellow-breasted chat
IRBI	14	*Iridoprocne bicolor*	tree swallow
IXEX	3	*Ixobrychus exilis*	least bittern
IXNA	11	*Ixoreus naevius*	varied thrush
JUHY	5	*Junco hyemalis*	northern junco
LAAR	3	*Larus argentatus*	herring gull
LACA	3	*Larus californicus*	California gull
LACI	9	*Lasiurus cinereus*	hoary bat
LACU	15	*lagurus curtatus*	sage vole
LADE	3	*Larus delawarensis*	ringed-billed gull
LAEX	7	*Lanius excubitor*	northern shrike
LALU	7	*Lanius ludovicianus*	loggerhead shrike
LANO	14	*Lasionycteris noctivagans*	silver-haired bat
LAPH	3	*Larus philadelphia*	Bonaparte's gull
LAPI	3	*Larus pipixcan*	Franklin's gull
LEAT	4	*Leucosticte atrata*	black rosy finch
LECA	5	*Lepus californicus*	black-tailed jackrabbit
LETO	5	*Lepus townsendi*	white-tailed jackrabbit
LIFE	3	*Limosa fedoa*	marbled godwit
LISC	3	*Limodromus scolopaceus*	long-billed dowitcher
LOCA	5	*Lophortyx californicus*	California quail
LOCO	14	*Lophodytes cucullatus*	hooded merganser
LOLO	3	*Lobipes lobates*	northern phalarope
LUCA	16	*Lutra canadensis*	river otter
LYRU	4	*Lynx rufus*	bobcat
MAFL	4	*Marmota flaviventris*	yellow-bellied marmot
MATA	5	*Masticophis taeniatus*	striped whipsnake
MEAL	16	*Megaceryle alcyon*	belted kingfisher
MELE	13	*Melanerpes lewis*	Lewis' woodpecker
MELI	6	*Melospiza lincolnii*	Lincoln's sparrow
MEMEL	7	*Melospiza melodia*	song sparrow
MEMEP	15	*Mephitis mephitis*	striped skunk
MEMER	14	*Mergus merganser*	common merganser
MESE	3	*Mergus serrator*	red-breasted merganser
MILO	15	*Microtus longicaudis*	long-tailed vole
MIME	15	*Microdipodops megacephalus*	dark kangaroo mouse
MIMO	15	*Microtus montanus*	montane vole
MIPO	7	*Mimulus polyglottos*	northern mockingbird
MOAT	7	*Molothrus ater*	brown-headed cowbird
MUER	15	*Mustela erminea*	short-tailed weasel
MUFR	15	*Mustela frenata*	long-tailed weasel
MUVI	16	*Mustela vison*	mink
MYCA	4	*Myotis californicus*	California myotis

Letter code	Life form	Scientific name	Common name
MYCI	14	*Myiarchus cinerascens*	ash-throated flycatcher
MYEV	14	*Myotis evotis*	long-eared myotis
MYLE	4	*Myotis leibi*	small-footed myotis
MYLU	4	*Myotis lucifugus*	little brown myotis
MYTH	4	*Myotis thysanodes*	fringed myotis
MYTO	6	*Myadestes townsendi*	Townsend's solitaire
MYVO	14	*Myotis volans*	long-legged myotis
MYYU	14	*Myotis yumanensis*	Yuma myotis
NECI	4	*Neotoma cinerea*	bushy-tailed woodrat
NELE	4	*Neotoma lepida*	desert woodrat
NUAM	3	*Numenius americanus*	long-billed curlew
NUBO	10	*Nuttallornis borealis*	olive-sided flycatcher
NUCO	10	*Nucifraga columbiana*	Clark's nutcracker
NYNY	7	*Nycticorax nycticorax*	black-crowned night heron
ODHE	5	*Odocoileus hemionus*	mule deer
OLCO	3	*Olor columbianus*	whistling swan
ONLE	15	*Onychomys leucogastor*	northern grass-hopper mouse
ONZI	16	*Ondatra zibethicus*	muskrat
OPTO	7	*Oporornis tolmieri*	MacGillivray's warbler
ORMO	7	*Oreoscoptes montanus*	sage thrasher
ORPI	5	*Oreortyx pictus*	mountain quail
OTAS	14	*Otus asio*	common screech owl
OTFL	14	*Otus flammeolus*	flammulated owl
OVCA	5	*Ovis canadensis*	bighorn sheep
OXJA	3	*Oxyura jamaicensis*	ruddy duck
PAAMO	7	*Passerina amoena*	lazuli bunting
PAATR	14	*Parus atricapillus*	black-capped chickadee
PACY	8	*Passerina cyanea*	indigo bunting
PADO	14	*Passer domesticus*	house sparrow
PAGA	14	*Parus gambeli*	mountain chickadee

Letter code	Life form	Scientific name	Common name
PAHA	12	*Pandion haliaetus*	osprey
PAIL	7	*Passerella iliaca*	fox sparrow
PASA	5	*Passerculus sandwichensis*	savannah sparrow
PECA	11	*Perisoreus canadensis*	gray jay
PECR	4	*Peromyscus crinitis*	canyon mouse
PEERY	3	*Pelecanus erythrorhynchos*	American white pelican
PELO	15	*Perognathus longimembris*	little pocket mouse
PEMA	15	*Peromyscus maniculatus*	deer mouse
PEPA	15	*Perognathus parvus*	Great Basin pocket mouse
PEPER	5	*Perdix perdix*	grey partridge
PEPY	4	*Petrochelidon pyrrhonota*	cliff swallow
PHAU	3	*Phalacrocorax auritus*	double-crested cormorant
PHCOL	5	*Phasianus colchicus*	ring-necked pheasant
PHDO	5	*Phrynosoma douglassi*	short-horned lizard
PHLU	9	*Pheucticus ludovicianus*	rose-breasted grosbeak
PHME	11	*Pheucticus melanocephalus*	black-headed grosbeak
PHNU	6	*Phalaenoptilus nuttalli*	poorwill
PHPL	5	*Phrynosoma platyrhinos*	desert horned lizard
PIAL	13	*Picoides albolarvatus*	white-headed woodpecker
PICH	7	*Pipilo chlorura*	green-tailed towhee
PIER	7	*Pipilo erythrophthalmus*	rufous-sided towhee
PIHE	4	*Pipistrellus hesperus*	western pipistrelle
PILU	10	*Piranga ludoviciana*	western tanager western tanager
PIME	5	*Pituophis melanoleucus*	gopher snake
PIPI	7	*Pica pica*	black-billed magpie
PIPU	13	*Picoides pubescens*	downy woodpecker
PIVI	13	*Picoides villosus*	hairy woodpecker

Letter code	Life form	Scientific name	Common name
PLCH	7	*Plegadis chihi*	white-faced ibis
PLNI	5	*Plectrophenax nivalis*	snow bunting
PLTO	4	*Plecotus townsendi*	western big-eared bat
POAU	3	*Podiceps auritus*	horned grebe
POCAE	7	*Polioptila caerula*	blue-grey gnatcatcher
POCAR	3	*Porzana carolina*	sora
POGRA	5	*Pooecetes gramineus*	vesper sparrow
POGRI	3	*Podiceps grisegena*	red-necked grebe
PONIGR	3	*Podiceps nigricollis*	eared grebe
POPO	3	*Podilymbus podiceps*	pied-billed grebe
PRLO	14	*Procyon lotor*	raccoon
PSMI	8	*Psaltriparus minimus*	bushtit
RACA	1	*Rana catesbiana*	bullfrog
RALI	3	*Rallus limicola*	Virginia rail
RANO	5	*Rattus norvegicus*	Norway rat
RAPI	2	*Rana pipens*	leopard frog
RAPR	1	*Rana pretiosa*	spotted frog
RARA	5	*Rattus rattus*	black rat
REAM	3	*Recurvirostra americana*	American avocet
RECA	10	*Regulus calendula*	ruby-crowned kinglet
REME	15	*Reithrodontomys megalotis*	western harvest mouse
RESA	10	*Regulus satrapa*	golden-crowned kinglet
RIRI	16	*Riparia riparia*	bank swallow
SAOB	4	*Salpinctes obsoletus*	rock wren
SASA	4	*Sayornis saya*	Say's phoebe
SCGR	5	*Sceloporus graciosus*	sagebrush lizard
SCIN	2	*Schaphiopus intermontanus*	Great Basin spadefoot
SCOC	4	*Sceloporus occidentalis*	western fence lizard
SEAU	7	*Seiurus aurocapillus*	ovenbird
SEPL	7	*Selasphorus platycerus*	broad-tailed hummingbird
SERUF	11	*Selasphorus rufus*	rufous hummingbird
SERUT	9	*Setophaga ruticilla*	American redstart
SICAN	13	*Sitta canadensis*	red-breasted nuthatch
SICAR	13	*Sitta carolinensis*	white-breasted nuthatch
SICU	14	*Sialia currucoides*	mountain bluebird
SIME	14	*Sialia mexicanus*	western bluebird
SOME	15	*Sorex merriami*	Merriam shrew
SOPR	16	*Sorex preblei*	Malheur shrew
SOSE	15	*Sonora semiannulata*	western ground snake
SOSP	3	*Somateria spectabilis*	king eider
SOVA	16	*Sorex vagrans*	wandering shrew
SPARB	11	*Spizella arborea*	American tree sparrow
SPBE	15	*Spermophilus beldingi*	Belding ground squirrel
SPBRE	7	*Spizella breweri*	Brewer's sparrow
SPCO	15	*Spermophilus columbianus*	Columbian ground squirrel
SPLA	15	*Spermophilus lateralis*	mantled ground squirrel
SPPA	7	*Spizella passerina*	chipping sparrow
SPPU	4	*Spilogale putorius*	spotted skunk
SPRI	15	*Spermophilus richardsoni*	Richardson ground squirrel
SPTH	13	*Sphyrapicus thyroideus*	Williamson's sapsucker
SPTO	15	*Spermophilus townsendi*	Townsend ground squirrel
SPVAR	13	*Sphyrapicus varius*	yellow-bellied sapsucker
STCAL	7	*Stellula calliope*	calliope hummingbird
STCAS	3	*Sterna caspia*	Caspian tern
STFO	3	*Sterna forsteri*	Forster's tern
STNEG	5	*Sturnella neglecta*	western meadowlark
STRU	16	*Stelgidopteryx ruficollis*	rough-winged swallow
STTRI	3	*Steganopus tricolor*	Wilson's phalarope
STVU	14	*Sturnus vulgarius*	European starling
SYID	5	*Sylvilagus idahoensis*	pygmy rabbit
SYNU	5	*Sylvilagus nuttalli*	mountain cottontail

Letter code	Life form	Scientific name	Common name
TATA	15	*Taxidea taxus*	badger
TATH	14	*Tachycineta thalassina*	violet-green swallow
THEL	3	*Thamnophis elegans*	wandering garter snake
THSI	3	*Thamnophis sirtalis*	common garter snake
THTA	15	*Thomomys talpoides*	northern pocket gopher
THTO	15	*Thomomys townsendi*	Townsend pocket gopher
TORU	7	*Toxostoma rufum*	brown thrasher
TRAE	14	*Troglodytes aedon*	house wren
TRTR	3	*Troglodytes troglodytes*	winter wren
TUMI	7	*Turdus migratorius*	American robin
TRFL	3	*Tringa flavipes*	lesser yellowlegs
TRME	3	*Tringa melanoleuca*	greater yellowlegs
TRSO	7	*Tringa solitaria*	solitary sandpiper
TYAL	14	*Tyto alba*	barn owl
TYTY	7	*Tyrannus tyrannus*	eastern kingbird
TYVE	11	*Tyrannus verticalis*	western kingbird
UTST	5	*Uta stansburiana*	side-blotched lizard
VECE	6	*Vermivora celata*	orange-crowned warbler
VIGI	11	*Vireo gilvus*	warbling vireo
VIOL	11	*Vireo olivaceus*	red-eyed vireo
VISO	11	*Vireo solitarius*	solitary vireo
VUMA	15	*Vulpes macrotis*	kit fox
VUVU	15	*Vulpes vulpes*	red fox
WIPU	5	*Wilsonia pusilla*	Wilson's warbler
XAXA	7	*Xanthocephalus xanthocephalus*	yellow-headed blackbird
ZAPR	15	*Zapus princeps*	western jumping mouse
ZEMA	11	*Zenaida macroura*	mourning dove
ZOAT	7	*Zonotrichia atricapilla*	golden-crowned sparrow
ZOLE	7	*Zonotrichia leucophrys*	white-crowned sparrow

Appendix 3. Relative degree of use, by the life form, of plant communities and structural conditions (overstory and understory). Life form 1: reproduces in water, feeds in water. (2 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions													
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
		B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0				These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 0															
	F 0															
squaw apple/bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ pinegrass	R 0															
	F 0															
juniper/sagebrush/ bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ shrub	R 0															
	F 0															
quaking aspen/grass	R 0															
	F 0															
quaking aspen/mountain big sagebrush/bunchgrass	R 0															
	F 0															
riparian	R 2	2	2			2			2			2			2	
	F 2	2	2			2			2			2			2	

Appendix 3. Life form 2: reproduces in water; feeds on ground, in shrubs, and/or in trees. (6 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 1		1	0												
	F 2		2	1												
subalpine bunchgrass	R 0		0	0												
	F 1		1	1												
permanently wet meadows	R 2		2	0												
	F 5		5	2												
seasonally wet meadows	R 0		0	0												
	F 4		4	2												
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 3				3	0	1	3	0	1						
	F 3				2	3	2	2	3	2						
squaw apple/bunchgrass	R 0					0			0							
	F 1					1			1							
curlleaf mountainmahogany/ bunchgrass	R 0				0	0	0	0	0	0		0	0			
	F 1				1	1	1	1	1	1		1	1			
curlleaf mountainmahogany/ pinegrass	R 0				0	0	0	0	0	0		0	0			
	F 1				1	1	1	1	1	1		1	1			
juniper/sagebrush/ bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ shrub	R 0															
	F 0															
quaking aspen/grass	R 0				0	0	0	0	0	0	0	0	0	0	0	0
	F 4				2	4	2	2	4	2	1	4	4	1	3	2
quaking aspen/mountain big sagebrush/bunchgrass	R 0				0	0	0	0	0	0	0	0	0	0	0	0
	F 3				1	3	0	1	3	1	1	3	3	1	3	2
riparian	R 6				6	0	1	6	0	1	5	0	1	1	2	3
	F 6				2	6	3	2	6	3	1	5	5	1	3	3

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 3: reproduces on ground around water or on floating or emergent vegetation; feeds in water, on ground, in shrubs and trees. (44 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0															
	F 0															
subalpine bunchgrass	R 1	1	1	1												
	F 1	1	1	1												
permanently wet meadows	R 6	3	6	2												
	F 20	7	8	4												
seasonally wet meadows	R 5	3	5	2												
	F 9	7	8	4												
shadscale saltbush/ bunchgrass	R 1	1	1	1	1	1	1									
	F 1	1	1	1	1	1	1									
low sagebrush/bunchgrass	R 2	1	1	1	2	2	2									
	F 1	1	1	1	1	1	1									
black greasewood/grass	R 2	2	2	2	2	2	2	2	2	2						
	F 2	2	2	2	2	2	2	2	2	2						
tall sagebrush/bunchgrass	R 3	2	2	2	3	3	3	3	3	3						
	F 2	2	2	2	2	2	2	2	2	2						
squaw apple/bunchgrass	R 1	1	1	1	1	1	1	1	1	1						
	F 1	1	1	1	1	1	1	1	1	1						
curlleaf mountainmahogany/ bunchgrass	R 1	1	1	1	1	1	1	1	1	1	1	1	1			
	F 1	1	1	1	1	1	1	1	1	1	1	1	1			
curlleaf mountainmahogany/ pinegrass	R 1	1	1	1	1	1	1	1	1	1	1	1	1			
	F 1	1	1	1	1	1	1	1	1	1	1	1	1			
juniper/sagebrush/ bunchgrass	R 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	F 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
curlleaf mountainmahogany/ shrub	R 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	F 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
quaking aspen/grass	R 0															
	F 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
quaking aspen/mountain big sagebrush/bunchgrass	R 0															
	F 2	2	2'	2	2	2	2	2	2	2	2	2	2	2	2	2
riparian	R 38	3	25	3	4	35	11	4	28	11	3	6	10	4	25	10
	F 39	20	39	8	19	31	10	14	23	10	8	6	10	9	22	11

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 4: reproduces in cliffs, caves, rims and/or talus; feeds on ground or in air. (33 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 4	0	2	4												
	F 10	1	10	2												
subalpine bunchgrass	R 3	0	3	3												
	F 6	2	4	4												
permanently wet meadows	R 2	0	2	2												
	F 10	2	9	9												
seasonally wet meadows	R 1	0	1	1												
	F 9	2	8	8												
shadscale saltbush/ bunchgrass	R 6	2	5	5	1	4	4									
	F 11	5	10	10	3	8	8									
low sagebrush/bunchgrass	R 14	3	8	12	2	7	10									
	F 16	5	15	14	3	12	11									
black greasewood/grass	R 8	2	6	7	1	6	6	1	8	8						
	F 11	5	10	10	3	8	8	3	11	11						
tall sagebrush/bunchgrass	R 27	7	17	23	3	13	18	4	19	24						
	F 27	8	25	25	6	19	19	5	27	27						
squaw apple/bunchgrass	R 6	2	4	5	2	3	4	2	5	6						
	F 11	5	10	10	4	7	8	4	11	11						
curlleaf mountainmahogany/ bunchgrass	R 8	2	4	5	2	4	4	2	6	7	2	6	7			
	F 13	5	11	11	4	8	8	4	13	13	5	12	12			
curlleaf mountainmahogany/ pinegrass	R 8	2	4	5	2	3	4	2	6	7	2	6	7			
	F 13	5	11	11	4	8	8	4	13	13	5	12	12			
juniper/sagebrush/ bunchgrass	R 18	6	12	14	3	9	10	4	14	15	5	15	16	5	16	16
	F 21	7	19	19	5	14	14	6	21	21	10	20	20	9	20	20
curlleaf mountainmahogany/ shrub	R 8	2	4	5	2	3	4	2	6	7	2	6	7	2	6	7
	F 14	5	12	12	4	9	9	4	14	14	4	13	13	4	13	13
quaking aspen/grass	R 6	0	2	5	0	2	4	0	4	6	0	3	5	0	3	5
	F 9	2	7	7	2	6	6	2	9	9	2	8	8	2	8	8
quaking aspen/mountain big sagebrush/bunchgrass	R 6	0	2	5	0	2	4	0	4	6	0	3	5	0	3	5
	F 10	2	8	8	2	7	7	2	10	10	2	9	9	2	9	9
riparian	R 20	2	14	18	0	12	15	1	14	17	1	14	17	1	14	17
	F 28	4	26	25	4	22	21	5	27	27	7	26	26	8	26	26

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 5: reproduces on ground without specific water, cliff, rim or talus association; feeds on ground.(45 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function		Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R	3	1	1	2												
	F	6	1	3	4												
subalpine bunchgrass	R	1	0	0	1												
	F	5	0	5	5												
permanently wet meadows	R	6	0	4	2												
	F	16	1	16	12												
seasonally wet meadows	R	5	0	4	2												
	F	14	2	13	11												
shadscale saltbush/ bunchgrass	R	9	2	2	3	3	6	5									
	F	14	4	9	9	4	13	7									
low sagebrush/bunchgrass	R	22	3	8	9	4	13	14									
	F	24	7	16	17	6	20	16									
black greasewood/grass	R	13	1	1	2	2	8	8	2	11	11						
	F	18	3	9	9	5	14	11	5	18	16						
tall sagebrush/bunchgrass	R	31	3	9	6	4	17	15	3	22	21						
	F	32	7	19	17	8	24	19	6	30	25						
squaw apple/bunchgrass	R	5	0	1	3	0	3	4	0	3	4						
	F	14	1	10	12	1	12	12	1	13	13						
curlleaf mountainmahogany/ bunchgrass	R	7	0	0	2	0	3	3	0	4	6	0	2	4			
	F	19	1	11	13	2	14	13	1	18	17	0	16	16			
curlleaf mountainmahogany/ pinegrass	R	6	0	0	2	0	2	2	0	3	5	0	1	3			
	F	15	1	10	10	1	11	9	0	14	13	0	13	13			
juniper/sagebrush/ bunchgrass	R	19	1	2	4	2	10	7	2	14	12	2	7	7	2	11	10
	F	29	3	16	16	5	23	20	5	28	25	3	22	21	3	25	23
curlleaf mountainmahogany/ shrub	R	11	0	0	2	1	6	3	1	7	7	1	3	4	1	6	5
	F	17	0	9	9	1	13	10	1	16	14	1	13	13	1	16	15
quaking aspen/grass	R	11	0	1	1	0	6	3	0	9	5	0	3	2	0	9	6
	F	13	0	5	5	0	10	7	0	12	10	1	7	8	1	13	11
quaking aspen/mountain big sagebrush/bunchgrass	R	10	0	1	1	0	5	2	0	8	4	0	2	1	0	8	5
	F	14	0	5	5	0	10	8	0	13	10	0	9	8	0	13	11
riparian	R	22	0	6	2	0	15	7	0	17	11	0	5	4	0	16	10
	F	30	1	17	13	2	24	18	1	27	22	1	19	18	1	27	23

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 6: reproduces on ground; feeds in shrubs, trees, or air. (4 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
		B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0															
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0		0	0												
	F 2		2	2												
seasonally wet meadows	R 0		0	0												
	F 2		2	2												
shadscale saltbush/ bunchgrass	R 0		0	0	0	0	0									
	F 3		2	2	2	3	3									
low sagebrush/bunchgrass	R 2		0	0	0	2	1									
	F 3		2	2	2	3	3									
black greasewood/grass	R 0		0	0	0	0	0	0	0	0						
	F 3		2	2	2	3	3	2	3	3						
tall sagebrush/bunchgrass	R 3		0	0	0	3	2	0	3	2						
	F 3		2	2	2	3	3	2	3	3						
squaw apple/bunchgrass	R 0		0	0	0	0	0	0	0	0						
	F 3		2	2	2	3	3	2	3	3						
curlleaf mountainmahogany/ bunchgrass	R 1		0	0	0	1	1	0	1	1	0	1	1			
	F 2		1	1	1	2	2	1	2	2	1	2	2			
curlleaf mountainmahogany/ pinegrass	R 0		0	0	0	0	0	0	0	0	0	0	0			
	F 2		1	1	1	2	2	1	2	2	1	2	2			
juniper/sagebrush/ bunchgrass	R 2		0	0	0	2	2	0	2	2	0	2	2	0	2	2
	F 2		1	1	1	2	2	1	2	2	1	2	2	1	2	2
curlleaf mountainmahogany/ shrub	R 1		0	0	0	1	1	0	1	1	0	1	1	0	1	1
	F 2		1	1	1	2	2	1	2	2	1	2	2	1	2	2
quaking aspen/grass	R 1		0	0	0	1	0	0	1	0	0	1	0	0	1	0
	F 3		1	1	1	3	2	1	3	2	1	3	2	1	3	2
quaking aspen/mountain big sagebrush/bunchgrass	R 3		0	0	0	3	2	0	3	2	0	3	2	0	3	2
	F 3		1	1	1	3	2	1	3	2	1	3	2	1	3	2
riparian	R 1		0	0	0	1	0	0	1	0	0	1	0	0	1	0
	F 4		1	1	1	4	3	2	4	3	1	3	2	1	3	2

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 7: reproduces in shrubs; feeds on ground, in water or air. (29 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R		0	0	These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F		1	1												
subalpine bunchgrass	R		0	0												
	F		1	1												
permanently wet meadows	R		3	0												
	F		8	1												
seasonally wet meadows	R		3	0												
	F		8	0												
shadscale saltbush/ bunchgrass	R		0	0		0	0									
	F		4	1		6	4									
low sagebrush/bunchgrass	R		0	0		0	0									
	F		5	2		8	6									
black greasewood/grass	R		0	0		0	0		0	1						
	F		5	2		9	6		12	9						
tall sagebrush/bunchgrass	R		3	0		6	3		18	14						
	F		5	2		12	10		21	18						
squaw apple/bunchgrass	R		0	0		1	1		2	2						
	F		4	1		11	8		15	12						
curlleaf mountainmahogany/ bunchgrass	R		0	0		1	1		4	4		2	2			
	F		6	2		13	10		19	16		14	12			
curlleaf mountainmahogany/ pinegrass	R		0	0		1	1		4	4		2	2			
	F		6	2		13	10		19	16		14	12			
juniper/sagebrush/ bunchgrass	R		2	0		4	2		17	13		11	7		18	14
	F		8	2		15	11		25	20		19	15		25	21
curlleaf mountainmahogany/ shrub	R		0	0		2	2		13	11		7	4		13	10
	F		8	2		15	11		26	21		20	16		26	22
quaking aspen/grass	R		3	0		4	1		19	11		14	7		18	11
	F		9	2		14	10		24	17		20	14		24	18
quaking aspen/mountain big sagebrush/bunchgrass	R		3	0		6	3		25	17		15	8		24	17
	F		9	2		15	11		28	21		22	16		28	22
riparian	R		3	0		4	1		21	14		14	7	1	22	15
	F		10	3		14	10		24	17		20	14	0	24	18

Appendix 3. Life form 8: reproduces in shrubs; feeds in shrubs, trees, or air. (5 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0				These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0					0	0									
	F 1					1	1									
low sagebrush/bunchgrass	R 0					0	0									
	F 1					1	1									
black greasewood/grass	R 0					0	0	0	0	0						
	F 1					1	1	0	1	1						
tall sagebrush/bunchgrass	R 1					0	0	0	1	1						
	F 4					2	2	0	4	4						
squaw apple/bunchgrass	R 0					0	0	0	0	0						
	F 4					2	2	0	4	4						
curlleaf mountainmahogany/ bunchgrass	R 0					0	0	0	0	0	0	0	0			
	F 4					2	2	0	4	4	0	3	3			
curlleaf mountainmahogany/ pinegrass	R 0					0	0	0	0	0	0	0	0			
	F 4					2	2	0	4	4	0	3	3			
juniper/sagebrush/ bunchgrass	R 1					0	0	0	1	1	0	0	0	0	1	1
	F 3					2	2	0	3	3	0	3	3	0	3	3
curlleaf mountainmahogany/ shrub	R 3					0	0	0	3	3	0	1	1	0	3	3
	F 4					2	2	0	4	4	0	3	3	0	4	4
quaking aspen/grass	R 1					0	0	0	1	1	0	1	1	0	1	1
	F 2					2	2	0	2	2	0	2	2	0	2	2
quaking aspen/mountain big sagebrush/bunchgrass	R 4					0	0	0	4	4	0	2	2	0	4	4
	F 4					2	2	0	4	4	0	3	3	0	4	4
riparian	R 5					0	0	0	5	5	0	2	2	0	5	5
	F 5					2	2	0	5	5	0	3	3	0	5	5

Appendix 3. Life form 9: reproduces primarily in deciduous trees; feeds in shrubs, trees, or air. (3 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R	0														
	F	0														
subalpine bunchgrass	R	0														
	F	0														
permanently wet meadows	R	0														
	F	0														
seasonally wet meadows	R	0														
	F	0														
shadscale saltbush/ bunchgrass	R	0														
	F	0														
low sagebrush/bunchgrass	R	0														
	F	0														
black greasewood/grass	R	0														
	F	0														
tall sagebrush/bunchgrass	R	0							0	0						
	F	1							1	0						
squaw apple/bunchgrass	R	0							0	0						
	F	1							1	0						
curlleaf mountainmahogany/ bunchgrass	R	0							0	0		0	0			
	F	1							1	0		1	0			
curlleaf mountainmahogany/ pinegrass	R	0							0	0		0	0			
	F	1							1	0		1	0			
juniper/sagebrush/ bunchgrass	R	1							0	0		0	0		1	1
	F	3							3	1		3	2		3	3
curlleaf mountainmahogany/ shrub	R	1							0	0		0	0		1	1
	F	2							2	0		2	1		2	2
quaking aspen/grass	R	3							2	0		1	0		3	3
	F	3							3	1		3	2		3	3
quaking aspen/mountain big sagebrush/bunchgrass	R	3							2	0		1	0		3	3
	F	3							3	1		3	2		3	3
riparian	R	3							2	0		1	0		3	3
	F	3							3	1		3	2		3	3

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 10: reproduces primarily in conifers; feeds in shrubs, trees, or air. (7 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0															
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 0					0	0	0	0	0						
	F 2					1	1	0	2	2						
squaw apple/bunchgrass	R 0					0	0	0	0	0						
	F 2					1	1	0	2	2						
curlleaf mountainmahogany/ bunchgrass	R 0					0	0	0	0	0	0	0	0			
	F 2					1	1	0	2	2	0	2	2			
curlleaf mountainmahogany/ pinegrass	R 0					0	0	0	0	0	0	0	0			
	F 2					1	1	0	2	2	0	2	2			
juniper/sagebrush/ bunchgrass	R 3					0	0	0	2	2	0	3	2	0	3	2
	F 5					1	1	0	3	3	1	5	4	1	5	4
curlleaf mountainmahogany/ shrub	R 1					0	0	0	1	1	0	1	1	0	1	1
	F 4					1	1	0	2	3	0	4	3	0	4	3
quaking aspen/grass	R 3					0	0	0	0	0	0	3	0	0	3	0
	F 6					1	1	0	3	3	1	6	4	1	6	4
quaking aspen/mountain big sagebrush/bunchgrass	R 5					0	0	0	1	1	0	4	1	0	5	2
	F 6					1	1	0	3	3	1	6	4	1	6	4
riparian	R 5					0	0	0	1	1	0	4	1	0	5	1
	F 7					1	1	0	3	3	1	6	4	1	6	4

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 11: reproduces in trees; feeds on ground, in shrubs, trees, or air. (13 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R	0	0													
	F	1	1													
subalpine bunchgrass	R	0	0													
	F	3	1													
permanently wet meadows	R	0	0													
	F	4	3													
seasonally wet meadows	R	0	0													
	F	4	4													
shadscale saltbush/ bunchgrass	R	0	0		0	0										
	F	2	4		2	1										
low sagebrush/bunchgrass	R	1	0		0	0										
	F	2	2		1	1										
black greasewood/grass	R	1	0		0	0		1	1							
	F	2	2		1	1		2	0							
tall sagebrush/bunchgrass	R	3	0		0	0		2	1							
	F	7	4		4	1		6	1							
squaw apple/bunchgrass	R	0	0		0	0		0	0							
	F	6	2		4	2		6	1							
curlleaf mountainmahogany/ bunchgrass	R	1	0		0	0		1	1		1	1	1			
	F	8	4		5	2		7	2		0	8	2			
curlleaf mountainmahogany/ pinegrass	R	1	0		0	0		1	1		1	1	1			
	F	8	4		5	2		7	2		0	8	2			
juniper/sagebrush/ bunchgrass	R	5	0		0	0		1	1		1	5	1	2	5	3
	F	10	4		4	2		8	2		0	10	2	1	10	7
curlleaf mountainmahogany/ shrub	R	2	0		0	0		1	1		1	2	1	1	2	2
	F	8	4		5	2		7	2		0	8	2	1	8	5
quaking aspen/grass	R	13	0		0	0		2	1		1	10	3	2	12	9
	F	13	4		5	2		8	2		0	12	3	1	13	8
quaking aspen/mountain big sagebrush/bunchgrass	R	12	0		0	0		2	1		1	10	2	2	12	8
	F	13	4		5	2		8	2		0	12	3	1	13	8
riparian	R	13	0		0	0		2	1		1	10	3	2	12	9
	F	13	4		5	2		8	2		0	12	3	1	13	8

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 12: reproduces on very thick branches; feeds on ground or in water. (6 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R		0	0												
	F		1	1												
subalpine bunchgrass	R		0	0												
	F		2	2												
permanently wet meadows	R		0	0												
	F		5	3												
seasonally wet meadows	R		0	0												
	F		5	3												
shadscale saltbush/bunchgrass	R		0	0		0	0									
	F		3	3		3	3									
low sagebrush/bunchgrass	R		0	0		0	0									
	F		3	3		3	3									
black greasewood grass	R		0	0		0	0		0	0						
	F		3	3		3	3		3	3						
tall sagebrush/bunchgrass	R		0	0		0	0		0	0						
	F		3	3		3	3		3	3						
squaw apple/bunchgrass	R		0	0		0	0		0	0						
	F		3	3		3	3		3	3						
curlleaf mountainmahogany/bunchgrass	R		0	0		0	0		0	0	0	0	0			
	F		3	3		3	3		3	3	0	3	3			
curlleaf mountainmahogany/pinegrass	R		0	0		0	0		0	0	0	0	0			
	F		3	3		3	3		3	3	0	3	3			
juniper/sagebrush/bunchgrass	R		0	0		0	0		2	0	5	5	5	5	5	5
	F		3	3		3	3		3	3	0	3	3	0	3	3
curlleaf mountainmahogany/shrub	R		0	0		0	0		0	0	0	3	3	0	3	3
	F		3	3		3	3		3	3	0	3	3	0	3	3
quaking aspen/grass	R		0	0		0	0		2	0	4	4	4	4	4	4
	F		3	3		3	3		3	3	0	3	3	0	3	3
quaking aspen/mountain big sagebrush/bunchgrass	R		0	0		0	0		2	0	4	4	4	4	4	4
	F		3	3		3	3		3	3	0	3	3	0	3	3
riparian	R		0	0		0	0		2	0	5	5	6	5	5	6
	F		5	3		3	3		3	3	0	3	3	0	3	3

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 3. Life form 13: reproduces – excavates own hole in a tree; feeds on ground, in shrubs, trees, or air. (9 species)

R – reproduction F – feeding B.G. – bare ground Ann. – annuals Bunch. – native bunchgrass		Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
Plant community	Function	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0		0		These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0		0													
subalpine bunchgrass	R 0		0													
	F 0		0													
permanently wet meadows	R 0		0													
	F 0		0													
seasonally wet meadows	R 0		0													
	F 0		0													
shadscale saltbush/ bunchgrass	R 0		0			0										
	F 1		1			1										
low sagebrush/bunchgrass	R 0		0			0										
	F 1		1			1										
black greasewood/grass	R 0		0			0			0							
	F 1		1			1			1							
tall sagebrush/bunchgrass	R 0		0			0			0							
	F 1		1			1			1							
squaw apple/bunchgrass	R 0		0			0			0							
	F 1		1			1			1							
curlleaf mountainmahogany/ bunchgrass	R 0		0			0			0		0	0	0			
	F 1		1			1			1		1	1	1			
curlleaf mountainmahogany/ pinegrass	R 0		0			0			0		0	0	0			
	F 1		1			1			1		1	1	1			
juniper/sagebrush/ bunchgrass	R 6		0			0			0		3	5	3	5	6	6
	F 6		1			1			3		3	5	3	5	6	6
curlleaf mountainmahogany/ shrub	R 0		0			0			0		0	0	0	0	0	0
	F 1		1			1			1		1	1	1	1	1	1
quaking aspen/grass	R 6		0			0			0		2	5	2	4	6	6
	F 9		1			2			5		4	8	4	6	9	9
quaking aspen/mountain big sagebrush/bunchgrass	R 6		0			0			0		2	5	2	4	6	6
	F 9		1			2			5		4	8	4	6	9	9
riparian	R 8		0			0			0		3	7	3	5	8	8
	F 9		1			2			5		4	8	4	6	9	9

Appendix 3. Life form 14: reproduces in a hole made by another species or that has occurred naturally; feeds on ground, in water, or air. (25 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0		0	0	These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0		0	0												
subalpine bunchgrass	R 0		0	0												
	F 0		0	0												
permanently wet meadows	R 0		0	0												
	F 12		10	3												
seasonally wet meadows	R 0		0	0												
	F 12		10	3												
shadscale saltbush/ bunchgrass	R 0		0	0		0	0									
	F 6		2	2		2	6									
low sagebrush/bunchgrass	R 0		0	0		0	0									
	F 11		6	2		4	7									
black greasewood/grass	R 0		0	0		0	0		0	0						
	F 6		2	2		2	6		2	6						
tall sagebrush/bunchgrass	R 0		0	0		0	0		0	0						
	F 15		8	3		7	10		11	10						
squaw apple/bunchgrass	R 0		0	0		0	0		0	0						
	F 7		3	3		3	7		3	7						
curlleaf mountainmahogany/ bunchgrass	R 0		0	0		0	0		0	0	0	0	0			
	F 6		2	2		2	6		2	6	5	5	5			
curlleaf mountainmahogany/ pinegrass	R 0		0	0		0	0		0	0	0	0	0			
	F 10		3	2		4	8		5	8	6	8	7			
juniper/sagebrush/ bunchgrass	R 10		0	0		0	0		0	0	3	9	6	4	9	6
	F 14		6	3		5	8		9	8	6	12	9	8	13	10
curlleaf mountainmahogany/ shrub	R 1		0	0		0	0		0	0	0	1	0	0	1	0
	F 13		5	2		4	8		8	8	6	11	9	7	12	10
quaking aspen/grass	R 15		0	0		0	0		0	0	5	11	7	6	11	8
	F 15		8	3		8	5		13	5	3	11	7	4	11	8
quaking aspen/mountain big sagebrush/bunchgrass	R 15		0	0		0	0		0	0	5	11	7	6	11	8
	F 15		8	3		8	5		13	5	3	11	7	4	11	8
riparian	R 24		0	0		0	0		0	0	8	19	14	10	21	16
	F 24		11	3		10	11		16	11	6	17	12	8	19	14

Appendix 3. Life form 15: reproduces – underground burrow; feeds on or under ground. (32 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function		Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R	8	0	3	5	These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F	8	0	6	6												
subalpine bunchgrass	R	9	0	2	6												
	F	9	0	5	7												
permanently wet meadows	R	10	0	4	7												
	F	11	0	7	9												
seasonally wet meadows	R	7	0	2	4												
	F	8	0	5	6												
shadscale saltbush/ bunchgrass	R	13	0	4	4	0	6	9									
	F	13	1	5	5	1	7	9									
low sagebrush/bunchgrass	R	13	0	5	7	0	5	10									
	F	13	1	7	8	1	8	10									
black greasewood/grass	R	12	0	3	3	0	3	6	0	6	10						
	F	13	1	5	5	1	5	7	1	8	10						
tall sagebrush/bunchgrass	R	22	0	5	10	0	6	12	0	12	15						
	F	22	1	8	11	1	8	12	1	14	16						
squaw apple/bunchgrass	R	4	0	1	1	0	1	2	0	3	4						
	F	5	0	3	3	0	2	3	0	3	4						
curlleaf mountainmahogany/ bunchgrass	R	6	0	1	1	0	1	3	0	3	6		4	6			
	F	6	0	3	2	0	2	3	0	4	6		5	6			
curlleaf mountainmahogany/ pinegrass	R	6	0	1	1	0	1	3	0	3	6		4	6			
	F	6	0	3	2	0	2	3	0	4	6		5	6			
juniper/sagebrush/ bunchgrass	R	12	0	1	4	0	1	6	0	9	12		9	13		9	13
	F	12	0	4	5	0	3	6	0	9	12		10	13		10	13
curlleaf mountainmahogany/ shrub	R	6	0	1	1	0	1	3	0	3	6		4	6		4	6
	F	6	0	3	2	0	2	3	0	4	6		5	6		5	6
quaking aspen/grass	R	2	0	1	1	0	1	1	0	2	2		2	2		2	2
	F	2	0	1	1	0	1	1	0	2	2		2	2		2	2
quaking aspen/mountain big sagebrush/bunchgrass	R	2	0	1	1	0	1	1	0	2	2		2	2		2	2
	F	2	0	1	1	0	1	1	0	2	2		2	2		2	2
riparian	R	15	0	3	7	0	3	7	0	8	9		7	11		10	14
	F	16	0	6	9	0	5	8	0	8	9		9	12		10	14

Appendix 3. Life form 16: reproduces – underground burrow; feeds in water, on ground, or in air. (9 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0		0	0	These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0		0	0												
subalpine bunchgrass	R 2		0	2												
	F 2		0	2												
permanently wet meadows	R 2		0	2												
	F 4		2	2												
seasonally wet meadows	R 0		0	0												
	F 2		2	0												
shadscale saltbush/ bunchgrass	R 0		0	0		0	0									
	F 0		0	0		0	0									
low sagebrush/bunchgrass	R 0		0	0		0	0									
	F 0		0	0		0	0									
black greasewood/grass	R 0		0	0		0	0		0	0						
	F 0		0	0		0	0		0	0						
tall sagebrush/bunchgrass	R 1		0	1		0	1		0	1						
	F 3		2	1		2	3		2	3						
squaw apple/bunchgrass	R 0		0	0		0	0		0	0						
	F 0		0	0		0	0		0	0						
curlleaf mountainmahogany/ bunchgrass	R 0		0	0		0	0		0	0		0	0			
	F 0		0	0		0	0		0	0		0	0			
curlleaf mountainmahogany/ pinegrass	R 0		0	0		0	0		0	0		0	0			
	F 0		0	0		0	0		0	0		0	0			
juniper/sagebrush/ bunchgrass	R 0		0	0		0	0		0	0		0	0		0	0
	F 0		0	0		0	0		0	0		0	0		0	0
curlleaf mountainmahogany/ shrub	R 0		0	0		0	0		0	0		0	0		0	0
	F 0		0	0		0	0		0	0		0	0		0	0
quaking aspen/grass	R 0		0	0		0	0		0	0		0	0		0	0
	F 2		2	0		2	2		2	2		2	2		2	2
quaking aspen/mountain big sagebrush/bunchgrass	R 0		0	0		0	0		0	0		0	0		0	0
	F 2		2	0		2	2		2	2		2	2		2	2
riparian	R 9		0	2		2	4		5	7		3	5		6	8
	F 9		4	2		2	4		5	7		6	5		6	8

Appendix 4. Relative degree of use, by the life form, of plant communities and structural conditions (overstory without the refinements of the understory in appendix 3). Life form 1: reproduces in water; feeds in water. (2 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
		B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0				These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 0															
	F 0															
squaw apple/bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ pinegrass	R 0															
	F 0															
juniper/sagebrush/ bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ shrub	R 0															
	F 0															
quaking aspen/grass	R 0															
	F 0															
quaking aspen/mountain big sagebrush/bunchgrass	R 0															
	F 0															
riparian	R 2		2			2			2			2			2	
	F 2		2			2			2			2			2	

Appendix 4. Life form 2: reproduces in water; feeds on ground, in shrubs, and/or in trees. (6 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0		1													
	F 0		2													
subalpine bunchgrass	R 0		0													
	F 1		1													
permanently wet meadows	R 2		2													
	F 5		5													
seasonally wet meadows	R 0		0													
	F 4		4													
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 3					3			3							
	F 3					3			3							
squaw apple/bunchgrass	R 0					0			0							
	F 1					1			1							
curlleaf mountainmahogany/ bunchgrass	R 0					0			0			0				
	F 1					1			1			1				
curlleaf mountainmahogany/ pinegrass	R 0					0			0			0				
	F 1					1			1			1				
juniper/sagebrush/ bunchgrass	R 0															
	F 0															
curlleaf mountainmahogany/ shrub	R 0															
	F 0															
quaking aspen/grass	R 0					0			0			0			0	
	F 4					4			4			4			3	
quaking aspen/mountain big sagebrush/bunchgrass	R 0					0			0			0			0	
	F 3					3			3			3			3	
riparian	R 6					6			6			5			3	
	F 6					6			6			5			3	

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 3: reproduces on ground around water, or on floating or emergent vegetation; feeds in water, on ground, in shrubs and trees. (44 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function		Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R	0															
	F	0															
subalpine bunchgrass	R	1		1													
	F	1		1													
permanently wet meadows	R	6		6													
	F	20		20													
seasonally wet meadows	R	5		5													
	F	9		9													
shadscale saltbush/ bunchgrass	R	1		1			1										
	F	1		1			1										
low sagebrush/bunchgrass	R	2		1			1										
	F	1		1			1										
black greasewood/grass	R	2		2			2			2							
	F	2		2			2			2							
tall sagebrush/bunchgrass	R	2		2			2			2							
	F	2		2			2			2							
squaw apple/bunchgrass	R	1		1			1			1							
	F	1		1			1			1							
curlleaf mountainmahogany/ bunchgrass	R	1		1			1			1			1				
	F	1		1			1			1			1				
curlleaf mountainmahogany/ pinegrass	R	1		1			1			1			1				
	F	1		1			1			1			1				
juniper/sagebrush/ bunchgrass	R	2		2			2			2			2			2	
	F	2		2			2			2			2			2	
curlleaf mountainmahogany/ shrub	R	1		1			1			1			1			1	
	F	1		1			1			1			1			1	
quaking aspen/grass	R	0															
	F	2		2			2			2			2			2	
quaking aspen/mountain big sagebrush/bunchgrass	R	0															
	F	2		2			2			2			2			2	
riparian	R	38		25			35			28			10			25	
	F	39		39			31			23			10			22	

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 4: reproduces in cliffs, caves, rims and/or talus; feeds on ground or in air. (33 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 4	4														
	F 10	10														
subalpine bunchgrass	R 3	33														
	F 6	4														
permanently wet meadows	R 2	2														
	F 10	9														
seasonally wet meadows	R 1	1														
	F 9	8														
shadscale saltbush/ bunchgrass	R 6	5			4											
	F 11	10			8											
low sagebrush/bunchgrass	R 14	12			10											
	F 16	15			12											
black greasewood/grass	R 8	7			6			8								
	F 11	10			8			11								
tall sagebrush/bunchgrass	R 27	23			18			24								
	F 27	25			19			27								
squaw apple/bunchgrass	R 6	5			4			6								
	F 11	10			8			11								
curlleaf mountainmahogany/ bunchgrass	R 8	5			4			7			7					
	F 13	11			8			13			12					
curlleaf mountainmahogany/ pinegrass	R 8	5			4			7			7					
	F 13	11			8			13			12					
juniper/sagebrush/ bunchgrass	R 18	14			10			15			16			16		
	F 21	19			14			21			20			20		
curlleaf mountainmahogany/ shrub	R 8	5			4			7			7			7		
	F 14	12			9			14			13			13		
quaking aspen/grass	R 6	5			4			6			5			5		
	F 9	7			6			9			8			8		
quaking aspen/mountain big sagebrush/bunchgrass	R 6	5			4			6			5			5		
	F 10	8			7			10			9			9		
riparian	R 20	18			15			17			17			17		
	F 28	26			22			27			26			26		

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 5: reproduces on ground without specific water, cliff, rim or talus association; feeds on ground. (45 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 3		2													
	F 6		4													
subalpine bunchgrass	R 1		1													
	F 5		5													
permanently wet meadows	R 6		4													
	F 16		16													
seasonally wet meadows	R 5		4													
	F 14		13													
shadscale saltbush/ bunchgrass	R 9		3			6										
	F 14		9			13										
low sagebrush/bunchgrass	R 22		9			14										
	F 24		17			20										
black greasewood/grass	R 13		2			8			11							
	F 18		9			14			18							
tall sagebrush/bunchgrass	R 31		9			17			22							
	F 32		19			24			30							
squaw apple/bunchgrass	R 5		3			4			4							
	F 14		12			12			13							
curlleaf mountainmahogany/ bunchgrass	R 7		2			3			6			4				
	F 19		13			14			18			16				
curlleaf mountainmahogany/ pinegrass	R 6		2			2			5			3				
	F 15		10			11			14			13				
juniper/sagebrush/ bunchgrass	R 19		4			10			14			7			11	
	F 29		16			23			28			22			25	
curlleaf mountainmahogany/ shrub	R 11		2			6			7			4			6	
	F 17		9			13			16			13			16	
quaking aspen/grass	R 11		1			6			9			3			9	
	F 13		5			10			12			8			13	
quaking aspen/mountain big sagebrush/bunchgrass	R 10		1			5			8			2			8	
	F 14		5			10			13			9			13	
riparian	R 22		6			15			17			5			16	
	F 30		17			24			27			19			27	

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 6: reproduces on ground; feeds in shrubs, trees, or air. (4 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
		B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0															
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0		0													
	F 2		2													
seasonally wet meadows	R 0		0													
	F 2		2													
shadscale saltbush/ bunchgrass	R 0		0			0										
	F 3		2			3										
low sagebrush/bunchgrass	R 2		0			2										
	F 3		2			3										
black greasewood/grass	R 0		0			0			0							
	F 3		2			3			3							
tall sagebrush/bunchgrass	R 3		0			3			3							
	F 3		2			3			3							
squaw apple/bunchgrass	R 0		0			0			0							
	F 3		2			3			3							
curlleaf mountainmahogany/ bunchgrass	R 1		0			1			1			1				
	F 2		1			2			2			2				
curlleaf mountainmahogany/ pinegrass	R 0		0			0			0			0				
	F 2		1			2			2			2				
juniper/sagebrush/ bunchgrass	R 2		0			2			2			2			2	
	F 2		1			2			2			2			2	
curlleaf mountainmahogany/ shrub	R 1		0			1			1			1			1	
	F 2		1			2			2			2			2	
quaking aspen/grass	R 1		0			1			1			1			1	
	F 3		1			3			3			3			3	
quaking aspen/mountain big sagebrush/bunchgrass	R 3		0			3			3			3			3	
	F 3		1			3			3			3			3	
riparian	R 1		0			1			1			1			1	
	F 4		1			4			4			3			3	

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 7: reproduces in shrubs; feeds on ground, in water or air. (29 species)

R – reproduction F – feeding B.G. – bare ground Ann. – annuals Bunch. – native bunchgrass		Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
Plant community	Function	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R		0		These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F		1													
subalpine bunchgrass	R		0													
	F		1													
permanently wet meadows	R		3													
	F		8													
seasonally wet meadows	R		3													
	F		8													
shadscale saltbush/ bunchgrass	R		0			0										
	F		4			6										
low sagebrush/bunchgrass	R		0			0										
	F		5			8										
black greasewood/grass	R		0			0			1							
	F		5			9			12							
tall sagebrush/bunchgrass	R		3			6			18							
	F		5			12			21							
squaw apple/bunchgrass	R		0			1			2							
	F		4			11			15							
curlleaf mountainmahogany/ bunchgrass	R		0			1			4			2				
	F		6			13			19			14				
curlleaf mountainmahogany/ pinegrass	R		0			1			4			2				
	F		6			13			19			14				
juniper/sagebrush/ bunchgrass	R		2			4			17			11			18	
	F		8			15			25			19			25	
curlleaf mountainmahogany/ shrub	R		0			2			13			7			13	
	F		8			15			26			20			26	
quaking aspen/grass	R		3			4			19			14			18	
	F		9			14			24			20			24	
quaking aspen/mountain big sagebrush/bunchgrass	R		3			6			25			15			24	
	F		9			15			28			22			28	
riparian	R		3			4			21			14			22	
	F		10			14			24			20			24	

Appendix 4. Life form 8: reproduces in shrubs; feeds in shrubs, trees, or air. (5 species)

R – reproduction F – feeding B.G. – bare ground Ann. – annuals Bunch. – native bunchgrass		Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
Plant community	Function	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0				These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0				0											
	F 1				1											
low sagebrush/bunchgrass	R 0				0											
	F 1				1											
black greasewood/grass	R 0				0			0								
	F 1				1			1								
tall sagebrush/bunchgrass	R 1				0			1								
	F 4				2			4								
squaw apple/bunchgrass	R 0				0			0								
	F 4				2			4								
curlleaf mountainmahogany/ bunchgrass	R 0				0			0			0					
	F 4				2			4			3					
curlleaf mountainmahogany/ pinegrass	R 0				0			0			0					
	F 4				2			4			3					
juniper/sagebrush/ bunchgrass	R 1				0			1			0			1		
	F 3				2			3			3			3		
curlleaf mountainmahogany/ shrub	R 3				0			3			1			3		
	F 4				2			4			3			4		
quaking aspen/grass	R 1				0			1			1			1		
	F 2				2			2			2			2		
quaking aspen/mountain big sagebrush/bunchgrass	R 4				0			4			2			4		
	F 4				2			4			3			4		
riparian	R 5				0			5			2			5		
	F 5				2			5			3			5		

Appendix 4. Life form 9: reproduces primarily in deciduous trees; feeds in shrubs, trees, or air. (3 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0															
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 0							0								
	F 1							1								
squaw apple/bunchgrass	R 0							0								
	F 1							1								
curlleaf mountainmahogany/ bunchgrass	R 0							0			0					
	F 1							1			1					
curlleaf mountainmahogany/ pinegrass	R 0							0			0					
	F 1							1			1					
juniper/sagebrush/ bunchgrass	R 1							0			0			1		
	F 3							3			3			3		
curlleaf mountainmahogany/ shrub	R 1							0			0			1		
	F 2							2			2			2		
quaking aspen/grass	R 3							2			1			3		
	F 3							3			3			3		
quaking aspen/mountain big sagebrush/bunchgrass	R 3							2			1			3		
	F 3							3			3			3		
riparian	R 3							2			1			3		
	F 3							3			3			3		

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 10: reproduces primarily in conifers; feeds in shrubs, trees, or air. (7 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0				These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0															
subalpine bunchgrass	R 0															
	F 0															
permanently wet meadows	R 0															
	F 0															
seasonally wet meadows	R 0															
	F 0															
shadscale saltbush/ bunchgrass	R 0															
	F 0															
low sagebrush/bunchgrass	R 0															
	F 0															
black greasewood/grass	R 0															
	F 0															
tall sagebrush/bunchgrass	R 0					0			0							
	F 2					1			2							
squaw apple/bunchgrass	R 0					0			0							
	F 2					1			2							
curlleaf mountainmahogany/ bunchgrass	R 0					0			0			0				
	F 2					1			2			2				
curlleaf mountainmahogany/ pinegrass	R 0					0			0			0				
	F 2					1			2			2				
juniper/sagebrush/ bunchgrass	R 3					0			2			3			3	
	F 5					1			3			5			5	
curlleaf mountainmahogany/ shrub	R 1					0			1			1			1	
	F 4					1			3			4			4	
quaking aspen/grass	R 3					0			0			3			3	
	F 6					1			3			6			6	
quaking aspen/mountain big sagebrush/bunchgrass	R 5					0			1			4			5	
	F 6					1			3			6			6	
riparian	R 5					0			1			4			5	
	F 7					1			3			6			6	

Appendix 4. Life form 11: reproduces in trees; feeds on ground, in shrubs, trees, or air. (13 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function		Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R	0		0													
	F	1		1													
subalpine bunchgrass	R	0		0													
	F	3		1													
permanently wet meadows	R	0		0													
	F	4		3													
seasonally wet meadows	R	0		0													
	F	4		4													
shadscale saltbush/ bunchgrass	R	0		0			0										
	F	2		4			2										
low sagebrush/bunchgrass	R	1		0			0										
	F	2		2			1										
black greasewood/grass	R	1		0			0			1							
	F	2		2			1			2							
tall sagebrush/bunchgrass	R	3		0			0			2							
	F	7		4			4			6							
squaw apple/bunchgrass	R	0		0			0			0							
	F	6		2			4			6							
curlleaf mountainmahogany/ bunchgrass	R	1		0			0			1			1				
	F	8		4			5			7			8				
curlleaf mountainmahogany/ pinegrass	R	1		0			0			1			1				
	F	8		4			5			7			8				
juniper/sagebrush/ bunchgrass	R	5		0			0			1			5			5	
	F	10		4			4			8			10			10	
curlleaf mountainmahogany/ shrub	R	2		0			0			1			2			2	
	F	8		4			5			7			8			8	
quaking aspen/grass	R	13		0			0			2			11			13	
	F	13		4			5			8			12			13	
quaking aspen/mountain big sagebrush/bunchgrass	R	12		0			0			2			11			13	
	F	13		4			5			8			12			13	
riparian	R	13		0			0			2			11			13	
	F	13		4			5			8			12			13	

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 12: reproduces on very thick branches; feeds on ground or in water. (6 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0	0			These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 1	1														
subalpine bunchgrass	R 0	0														
	F 2	2														
permanently wet meadows	R 0	0														
	F 5	5														
seasonally wet meadows	R 0	0														
	F 5	5														
shadscale saltbush/ bunchgrass	R 0	0			0											
	F 3	3			3											
low sagebrush/bunchgrass	R 0	0			0											
	F 3	3			3											
black greasewood/grass	R 0	0			0			0								
	F 3	3			3			3								
tall sagebrush/bunchgrass	R 3	0			0			0								
	F 3	3			3			3								
squaw apple/bunchgrass	R 0	0			0			0								
	F 3	3			3			3								
curlleaf mountainmahogany/ bunchgrass	R 0	0			0			0			0					
	F 3	3			3			3			3					
curlleaf mountainmahogany/ pinegrass	R 0	0			0			0			0					
	F 3	3			3			3			3					
juniper/sagebrush/ bunchgrass	R 5	0			0			2			5			5		
	F 3	3			3			3			3			3		
curlleaf mountainmahogany/ shrub	R 3	0			0			0			3			3		
	F 3	3			3			3			3			3		
quaking aspen/grass	R 4	0			0			2			4			4		
	F 3	3			3			3			3			3		
quaking aspen/mountain big sagebrush/bunchgrass	R 4	0			0			2			4			4		
	F 3	3			3			3			3			3		
riparian	R 6	0			0			2			6			6		
	F 5	5			3			3			3			3		

Appendix 4. Life form 13: reproduces – excavates own hole in a tree; feeds on ground, in shrubs, trees, or air. (9 species)

R – reproduction F – feeding B.G. – bare ground Ann. – annuals Bunch. – native bunchgrass		Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
Plant community	Function	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 0		0		These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0		0													
subalpine bunchgrass	R 0		0													
	F 0		0													
permanently wet meadows	R 0		0													
	F 0		0													
seasonally wet meadows	R 0		0													
	F 0		0													
shadscale saltbush/ bunchgrass	R 0		0			0										
	F 1		1			1										
low sagebrush/bunchgrass	R 0		0			0										
	F 1		1			1										
black greasewood/grass	R 0		0			0			0							
	F 1		1			1			1							
tall sagebrush/bunchgrass	R 0		0			0			0							
	F 1		1			1			1							
squaw apple/bunchgrass	R 0		0			0			0							
	F 1		1			1			1							
curlleaf mountainmahogany/ bunchgrass	R 0		0			0			0			0				
	F 1		1			1			1			1				
curlleaf mountainmahogany/ pinegrass	R 0		0			0			0			0				
	F 1		1			1			1			1				
juniper/sagebrush/ bunchgrass	R 6		0			0			0			5			6	
	F 6		1			1			3			5			6	
curlleaf mountainmahogany/ shrub	R 0		0			0			0			0			0	
	F 1		1			1			1			1			1	
quaking aspen/grass	R 6		0			0			0			5			6	
	F 9		1			2			5			8			9	
quaking aspen/mountain big sagebrush/bunchgrass	R 6		0			0			0			5			6	
	F 9		1			2			5			8			9	
riparian	R 8		0			0			0			7			8	
	F 9		1			2			5			8			9	

Appendix 4. Life form 14: reproduces in a hole made by another species or that has occurred naturally; feeds on ground, in water, or air. (25 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0	0														
	F 0	0														
subalpine bunchgrass	R 0	0														
	F 0	0														
permanently wet meadows	R 0	0														
	F 12	10														
seasonally wet meadows	R 0	0														
	F 12	10														
shadscale saltbush/ bunchgrass	R 0	0			0											
	F 6	2			6											
low sagebrush/bunchgrass	R 0	0			0											
	F 11	6			7											
black greasewood/grass	R 0	0			0			0								
	F 6	2			6			6								
tall sagebrush/bunchgrass	R 0	0			0			0								
	F 15	8			10			11								
squaw apple/bunchgrass	R 0	0			0			0								
	F 7	3			7			7								
curlleaf mountainmahogany/ bunchgrass	R 0	0			0			0			0					
	F 6	2			6			6			5					
curlleaf mountainmahogany/ pinegrass	R 0	0			0			0			0					
	F 10	3			8			8			8					
juniper/sagebrush/ bunchgrass	R 10	0			0			0			9			9		
	F 14	6			8			9			12			13		
curlleaf mountainmahogany/ shrub	R 1	0			0			0			1			1		
	F 13	5			8			8			11			12		
quaking aspen/grass	R 15	0			0			0			12			12		
	F 15	8			8			13			12			12		
quaking aspen/mountain big sagebrush/bunchgrass	R 15	0			0			0			12			12		
	F 15	8			8			13			12			12		
riparian	R 24	0			0			0			19			21		
	F 24	11			11			16			17			19		

These plant communities do not achieve a habitat form like that characterized by these structural conditions.

Appendix 4. Life form 15: reproduces – underground burrow; feeds on or under ground. (32 species)

R – reproduction F – feeding B.G. – bare ground Ann. – annuals Bunch. – native bunchgrass		Structural conditions														
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub		
Plant community	Function	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.	B.G.	Ann.	Bunch.
crested wheatgrass (seeded)	R 8		5		These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 8		6													
subalpine bunchgrass	R 9		6													
	F 9		7													
permanently wet meadows	R 10		7													
	F 11		9													
seasonally wet meadows	R 7		4													
	F 8		6													
shadscale saltbush/ bunchgrass	R 13		4			9										
	F 13		5			9										
low sagebrush/bunchgrass	R 13		7			10										
	F 13		8			10										
black greasewood/grass	R 12		3			6			10							
	F 13		5			7			10							
tall sagebrush/bunchgrass	R 22		10			12			15							
	F 22		11			12			16							
squaw apple/bunchgrass	R 4		1			2			4							
	F 5		3			3			4							
curlleaf mountainmahogany/ bunchgrass	R 6		1			3			6			6				
	F 6		3			3			6			6				
curlleaf mountainmahogany/ pinegrass	R 6		1			3			6			6				
	F 6		3			3			6			6				
juniper/sagebrush/ bunchgrass	R 12		4			6			12			13			13	
	F 12		5			6			12			13			13	
curlleaf mountainmahogany/ shrub	R 6		1			3			6			6			6	
	F 6		3			3			6			6			6	
quaking aspen/grass	R 2		1			1			2			2			2	
	F 2		1			1			2			2			2	
quaking aspen/mountain big sagebrush/bunchgrass	R 2		1			1			2			2			2	
	F 2		1			1			2			2			2	
riparian	R 15		7			7			9			11			14	
	F 16		9			8			9			12			14	

Appendix 4. Life form 16: reproduces – underground burrow; feeds in water, on ground, or in air. (9 species)

R – reproduction
F – feeding
B.G. – bare ground
Ann. – annuals
Bunch. – native bunchgrass

Plant community	Function	Structural conditions: Grass-forb B.G.	Grass-forb Ann.	Grass-forb Bunch.	Low shrub B.G.	Low shrub Ann.	Low shrub Bunch.	Tall shrub B.G.	Tall shrub Ann.	Tall shrub Bunch.	Tree B.G.	Tree Ann.	Tree Bunch.	Tree/shrub B.G.	Tree/shrub Ann.	Tree/shrub Bunch.
crested wheatgrass (seeded)	R 0	0			These plant communities do not achieve a habitat form like that characterized by these structural conditions.											
	F 0	0														
subalpine bunchgrass	R 2	2														
	F 2	2														
permanently wet meadows	R 2	2														
	F 4	2														
seasonally wet meadows	R 0	0														
	F 2	2														
shadscale saltbush/ bunchgrass	R 0	0			0											
	F 0	0			0											
low sagebrush/bunchgrass	R 0	0			0											
	F 0	0			0											
black greasewood/grass	R 0	0			0			0								
	F 0	0			0			0								
tall sagebrush/bunchgrass	R 1	1			1			1								
	F 3	2			3			3								
squaw apple/bunchgrass	R 0	0			0			0								
	F 0	0			0			0								
curlleaf mountainmahogany/ bunchgrass	R 0	0			0			0			0					
	F 0	0			0			0			0					
curlleaf mountainmahogany/ pinegrass	R 0	0			0			0			0					
	F 0	0			0			0			0					
juniper/sagebrush/ bunchgrass	R 0	0			0			0			0			0		
	F 0	0			0			0			0			0		
curlleaf mountainmahogany/ shrub	R 0	0			0			0			0			0		
	F 0	0			0			0			0			0		
quaking aspen/grass	R 0	0			0			0			0			0		
	F 2	2			2			2			2			2		
quaking aspen/mountain big sagebrush/bunchgrass	R 0	0			0			0			0			0		
	F 2	2			2			2			2			2		
riparian	R 9	2			4			7			5			8		
	F 9	4			4			7			6			8		

Appendix 5. 72 wildlife species found in southeast Oregon during migration or incidental in the area.

Letter code	Life form	Common name
		BIRDS
GAIM	3	common loon
POGRI	3	red-necked grebe[1]
POAU	3	horned grebe
PEERY	3	American white pelican[1]
PLCH	7	white-faced ibis[1]
OLCO	3	whistling swan
ANAL	3	white-fronted goose[1]
CHCA	3	snow goose
CHRO	3	Ross' goose
AYMA	3	greater scaup
BUCL	3	common goldeneye
BUALBE	14	bufflehead
SOSP	3	king eider
CLHY	3	oldsquaw
LOCU	14	hooded merganser
MESE	3	red-breasted merganser
BULA	4	rough-legged hawk
HALE	12	bald eagle[1]
FAPE	4	peregrine[1]
FACO	11	merlin[1]
CHSEM	3	semipalmated plover
CHMO	3	mountain plover[1]
TRSO	7	solitary sandpiper[1]
TRFL	3	lesser yellowlegs
CASE	3	willet[1]
CAMEL	3	pectoral sandpiper
CABA	3	Baird's sandpiper[1]
CAMI	3	least sandpiper
CAMAU	3	western sandpiper
LISC	3	long-billed dowitcher
LIFE	3	marbled godwit
LOLO	3	northern phalarope
LAAR	3	herring gull
LADE	3	ring-billed gull
LAPH	3	Bonaparte's gull
ARAL	7	black-chinned hummingbird
SEPL	7	broad-tailed hummingbird
SERUF	11	rufous hummingbird
EMHA	11	Hammond's flycatcher
NUBO	10	olive-sided flycatcher
PECA	11	gray jay
NUCO	10	Clark's nutcracker
PAGA	14	mountain chickadee
TRTR	3	winter wren
MIPO	7	northern mockingbird
IXNA	11	varied thrush
CAGU	5	hermit thrush
RESA	10	golden-crowned kinglet
ANSP	5	water pipet
BOGA	9	bohemian waxwing
LAEX	7	northern shrike
VISO	11	solitary vireo
OPTO	7	MacGillivray's warbler
SEAU	7	ovenbird
SERUT	9	American redstart
PHLU	9	rose-breasted grosbeak
PHME	11	black-headed grosbeak
PACY	8	indigo bunting
HEVE	11	evening grosbeak
CACAS	11	Cassin's finch
LEAT	4	black rosy finch
CAFL	9	common redpoll
CAPI	11	pine siskin
SPARB	11	American tree sparrow
ZOLE	7	white-crowned sparrow
ZOAT	7	golden-crowned sparrow
PAIL	7	fox sparrow
MELI	6	Lincoln's sparrow[1]
CALA	5	Lapland longspur
PLNI	5	snow bunting
		MAMMALS
LANO	14	silver-haired bat
LACI	9	hoary bat

[1] Species of special interest; see appendix 13

Appendix 6. Wildlife orientation to plant communities by life form. Life form 1: reproduces in water; feeds in water. (2 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
		• – Primary (≥40%) reproduction and feeding							R – Primary (≥40%) reproduction only						F – Primary (≥40%) feeding only				
		0 – Secondary (<40%) reproduction and feeding							r – Secondary (<40%) reproduction only						f – Secondary (<40%) feeding only				
	AMPHIBIANS																		
RAPR	spotted frog																•	1	1
RACA	bullfrog								0								•	1	1
	R		0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		
	F		0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		

Appendix 6. Life form 2: reproduces in water; feeds on ground, in shrubs, and/or in trees. (6 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	AMPHIBIANS																		
AMMA	long-toed salamander			•			0										•	2	2
SCIN	Great Basin spadefoot toad	•		F	F			f	•	f	F	F	f	f	F	f	•	2	7
BUBO	western toad	f	F	F	F	f	r	f	•	F	f	f	f	f	F	F	•	2	8
BUWO	Woodhouse toad	F		F	F				f						F	F	•	1	5
HYRE	Pacific treefrog			•	F	0	0	0	•		0	(	)	0	F	F	•	3	6
RAPI	leopard frog			f				f	f						f	f	•	1	1
	R	1	0	2	0	0	0	0	3	0	0	0	0	0	0	0	6		
	F	2	1	5	4	0	0	0	3	1	1	1	0	0	4	3	6		

Appendix 6. Life form 3: reproduces on ground around water or on floating or emerging vegetation; feeds in water, on ground, in shrubs and trees. (44 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for:	
	REPTILES																	R	F
THST	common garter snake		•	•	•	•	•	•	•		•	•	•	•	F	F	•	12	14
THEL	wandering garter snake			•	•			•	•	•			•		F	F	•	7	9
	BIRDS																		
POAU	horned grebe																•	1	1
PONIGR	eared grebe																•	1	1
AEOC	western grebe																•	1	1
POPO	pied-billed grebe																•	1	1
PHAU	double-crested cormorant						R		R								F	2	1
BOLE	American bittern			f													•	1	1
IXEX	least bittern			f													•	1	1
BRCA	Canada goose																•	1	1
ANPL	mallard			F	f	0		0	0								•	1	2
ANSTR	gadwall			F	f	0		0	0								•	1	2
ANAC	common pintail			F	f	0		0	0								•	1	2
ANCR	green-winged teal			F	f	0		0	0								•	1	2
ANDIS	blue-winged teal			F	f	0		0	0								•	1	2
ANCY	cinnamon teal			F	f	0		0	0								•	1	2
ANAMEO	American wigeon			F	f	0		0	0								•	1	2
ANCL	northern shoveler			F	f	0		0	0								•	1	2
AYAM	redhead																•	1	1
AYCO	ring-necked duck			F	f												•	1	2
AYVA	canvasback																•	1	1
AYAF	lesser scaup																•	1	1
OXJA	ruddy duck																•	1	1
GRCA	sandhill crane			•	F												•	2	3
RALI	Virginia rail			F	f												•	1	2
POCAR	sora			F	f												•	1	2
FUAM	American coot			f	f												•	1	1
CHALE	snowy plover			F	F												F	0	3
CHVO	killdeer			•	•												•	3	3
CAGA	common snipe			•	•												•	3	3
ACMA	spotted sandpiper			f	f												•	1	1
TRME	greater yellowlegs																•	1	1
REAM	American avocet			•	•												•	3	3
HIME	black-necked stilt			f													•	1	1
STTRI	Wilson's phalarope																•	1	1
LACA	California gull			F	F												•	1	3
LAPI	Franklin's gull			F	F												•	1	3

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
STFO	Forster's tern		f	f													●	1	1
STCAS	Caspian tern		f	f													●	1	1
CHNI	black tern		f	f													●	1	1
CIME	dipper																●	1	1
CIPA	marsh wren		f	f													●	1	1
GETR	common yellowthroat		f	f													●	1	1
XAXA	yellow-headed blackbird		f	f				0									●	1	1
	R	0	1	6	5	1	2	2	3	1	1	1	2	1	0	0	38		
	F	0	1	20	9	1	1	2	2	1	1	1	2	1	2	2	39		

Appendix 6. Life form 4: reproduces in cliffs, caves, talus, rims and/or talus; feeds on ground or in air. (33 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	REPTILES																		
CRCO	collared lizard	0				●	●	●	●	●	●	●	●	●				9	9
SCOC	western fence lizard	0				0	0	0	●	●	●	●	●	●	0	0		6	6

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
CAAU	turkey vulture	F	F	F	F	F	●	F	●	F	F	F	●	F	F	F	F	3	16
BUREG	ferruginous hawk	0		f	f	F	●	●	●	F	f	f	●	F	●	●	●	7	10
FAME	prairie falcon	●	f	F	F	F	●	●	F	f	f	f	F	f	f	F	F	3	10
ALCH	chukar					F	●	F	●	●	F	F	f	F	f	f	F	3	9
COLI	rock dove	F					●		R								●	3	3
CYNI	black swift	●	f	F	F	f	●	f	●	f	f	f	f	f	f	f	F	3	6
AESA	white-throated swift	●	f	F	F	f	●	f	●	f	f	f	f	f	f	f	●	4	6
SASA	Say's phoebe	f		F	F	f	F	f	f	f	●	●	●	●	●	●	F	6	10
HIRU	barn swallow	F	f	F	F	f	f	f	●	F	F	F	F	F	●	●	●	4	12
PEPY	cliff swallow	F	f	F	F	f	f	f	●	F	F	F	F	F	F	F	●	2	12
COCOR	common raven	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	16	16
CAMEXO	canyon wren	F				●	●	●	f		f	f					F	3	5
SAOB	rock wren	F					●	●	●		f	f					F	3	5
LEAT	black rosy finch	f	●	f	f	f	f										f	1	1
	MAMMALS																		
MYLU	little brown myotis			f	f				●				●		0	0	●	3	3
MYTH	fringed myotis												●				●	2	2
MYCA	California myotis			f	f			f	●				●		0	0	●	3	3
MYLE	small-footed myotis								●								●	2	2
PIHE	western pipistrelle								●				f				●	2	2
EPFU	big brown bat		f	f	f			f	●		f	f	●	f	0	0	●	3	3
EUMAC	spotted bat					●			0								●	2	2
PLTO	western big-eared bat								●								●	2	2
ANPA	pallid bat			f	f	f	f	f	●	f			●		f	f	●	3	3
MAFL	yellow-bellied marmot		●	●	0		●		●	●	●	●	●	●	●	●	●	12	12
PECR	canyon mouse								●				●				●	3	3
NELE	desert woodrat					●	●	●	●									4	4
NECI	bushy-tailed woodrat					F	F	F	●	F	F	F	●	F				2	9
ERDO	porcupine		f	f	f				●		●	●	●	●	f	f	●	6	6
SPPU	spotted skunk								●				●				●	3	3
FECO	cougar		F						●		●	●	●	●	F	F	F	5	9
LYRU	bobcat		F	F	F	●	●	●	●	●	●	●	●	●	●	●	●	12	15
	R	4	3	2	1	6	14	8	27	6	8	8	18	8	6	6	20		
	F	10	6	10	9	11	16	11	27	11	13	13	21	14	9	10	28		

Appendix 6. Life form 5: reproduces on ground without specific water, cliff, rim or talus association; feeds on ground. (45 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	REPTILES																		
CRWI	leopard lizard					●	●	●	●	0	0	0	0	0				4	4
SCGR	sagebrush lizard						0	●	●	●	●	0	●	0				5	5
UTST	side-blotched lizard					●	●	●	●				●					5	5
PHPL	desert horned lizard	0				●	●	●	●	●	0	0	0	0				5	5
PHDO	short-horned lizard	0				0	●	0	●	0	0	0	●	0				3	3
EUSK	western skink							●	0	0			●	●			f	3	3
CNTI	western whiptail					●	●	●	●	0	0	0	●	●				6	6
CHBO	rubber boa						0		0		0	0	0	0	●		●	2	2
COCONS	yellow-bellied racer					0	●	●	●	0							●	4	4
MATA	striped whipsnake								●									1	1
PIME	gopher snake			●	0	0	0	●	●	0	0	0	●	0	0	0	●	5	5
HYTO	night snake					●	●		●				●					4	4
CRVI	western rattlesnake	●	●	●	●	●	●	●	●	●	●	●	●	●			●	14	14
	BIRDS																		
CICY	northern harrier	f	f	●	●	f	f	f	●	F	f	f	f	f			●	4	5
DEOB	blue grouse									f	f	f	●	●	●	●	●	5	5
BOUM	ruffed grouse									F	F	F	●	●	●	●	●	5	8
CEUR	sage grouse					F	●	F	●	f	f	f	F	F		F	F	2	8
LOCA	California quail								●	f	●	●	●	●	●	●	●	8	8
ORPI	mountain quail									f	F	F	●	●	f	F	F	2	6
PEPER	gray partridge	f		F	F		●	f	●	f	f	f	f	f			●	3	5
PHCOL	ring-necked pheasant			f	f		f		●	f		f	f	f	f		●	2	2
NUAM	long-billed curlew	f		F	F	●	●	f	●								●	4	6
ASFL	short-eared owl		f	●	●		f	f	●		F	F	F	F			●	4	8
ERAL	horned lark	●	f	F	F	f	●	0	●	0	F	F	f				f	3	7
CAFU	veery			f	f						f	f			0	0	●	1	1
WIPU	Wilson's warbler			f	f				f	f	f				●	●	●	3	3
DOOR	bobolink			●	●												●	3	3
STNEG	western meadowlark	F	f	F	F		●	0	●	●	0	0	●	0	●	●	F	6	10
PASA	savannah sparrow	f		f	f		●		0	F	F		F	f	f	f	f	1	4
AMSA	grasshopper sparrow	f		f	f		●		0	F	F		F	f	f	f	f	1	4
POGRA	vesper sparrow	f		f	f		●		0	F	F		F	f	f	f	f	1	4
CHGR	lark sparrow	f		F	F		●		●	f	F	F	F	F	●	●	●	5	11
JUHY	northern junco			F	F	●	●	●	●	●	●	●	●	●	●	●	●	12	14

Letter code	Species		crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for:	
	MAMMALS																		R	F
SYID	pygmy rabbit						●	●	●	●				●					5	5
SYNU	mountain cottontail						0	●	●	●	0	●	●	●	●			●	8	8
LETO	white-tailed jackrabbit		F	F	F	f				●	F	F	F	F	F			F	1	10
LECA	black-tailed jackrabbit		F	F	F	F	F	●	F	●	F	F	F	F	F			F	2	14
RARA	black rat									●						●	●	●	4	4
RANO	Norway rat									●						●	●	●	4	4
FECA	feral house cat								●					●		F	F	●	3	5
EQUA	feral horse				●	●	0	0	F	●	0	0	0	●	0	0	0	0	4	5
CEEL	elk											F	F	F	F	●	●	●	3	7
ODHE	mule deer		f	F	F	F	F	F	F	●	F	●	●	●	●	f	F	F	5	14
ANAMER	pronghorn		●				F	●	F	●	F	F	F	F	F			F	3	11
OVCA	bighorn sheep		f	F	F	F	F	F	f	F	f	●	●	f	●	f	f	F	3	10
		R	3	1	6	5	9	22	13	31	5	7	6	19	11	11	10	22		
		F	6	5	16	14	14	24	18	32	14	19	15	29	17	13	14	30		

Appendix 6. Life form 6: reproduces on ground; feeds in shrubs, trees, or air. (4 species)

Letter code	Species		crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for:	
	BIRDS																		R	F
PHNU	poorwill		f		F	F	F	●	F	●	F	f	f	f	f	f	f	F	2	8
CHMI	common nighthawk			f	F	F	F	●	F	●	F	●	F	●	F	F	●	F	5	14
MYTO	Townsend's solitaire						F	F	F	●	F	F	F	●	●	F	●	F	4	12
VECE	orange-crowned warbler															●	●	●	3	3
		R	0	0	0	0	0	2	0	3	0	1	0	2	1	1	3	1		
		F	0	0	2	2	3	3	3	3	3	2	2	2	2	3	3	4		

Appendix 6. Life form 7: reproduces in shrubs; feeds on ground, in water or air. (29 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curllea untainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for:	
	BIRDS																	R	F
BUST	green heron																●	1	1
BUIB	cattle egret	f		F	F				0						●	●	●	3	5
NYNY	black-crowned night heron			F	F				0						●	●	●	3	5
BUSW	Swainson's hawk			f	f	f	F	F	●	f	F	F	●	F	●	●	●	5	10
STCAL	calliope hummingbird			F	F								●	●	●	●	●	5	7
CAAN	Anna's hummingbird			F	F								●	●	●	●	●	5	7
TYTY	eastern kingbird						f	f	●	f	F	F	●	●	●	●	●	6	8
EMTR	willow flycatcher					F	F	F	F	F	F	F	F	F	●	●	●	3	12
EMWR	gray flycatcher					F	F	F	●	F	●	●	●	●	●	●	F	7	12
APCO	scrub jay			F	F		f	f	●	f	●	●	●	●	F	F	●	6	10
PIPI	black-billed magpie	F	F	F	F	F	F	F	●	●	●	●	●	●	●	●	●	9	16

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
DUCA	gray catbird						f	f	F	F	F	F	F	F	●	●	●	3	9
TORV	brown thrasher					f	●	F	●	F	F	F	●	●	F	●	●	6	11
ORMO	sage thrasher						F	F	●	F	f	f	●	●	f	●	f	4	7
TUMI	American robin			F	F				f		F	F	F	F	●	●	●	3	9
CAUS	Swainson's thrush						f	f	●	f	F	F	F	F	●	●	●	4	8
PACAE	blue-gray gnatcatcher								●	f	f	f	●	F	F	●	F	3	6
LALU	loggerhead shrike					F	F	●	●	F	F	F	●	●	F	F	●	5	12
AGPH	red-winged blackbird			●	●	F	F	F	●	F	F	F	F	F	●	●	●	6	14
EUCY	Brewer's blackbird	f		●	●	F	F	F	●	F	F	F	●	F	●	●	●	7	14
MOAT	brown-headed cowbird	f		●	●	F	F	F	●	F	F	F	●	F	●	●	●	7	14
PAAMO	lazuli bunting								f	f	f	f	f	F	●	●	●	3	4
CAPS	lesser goldfinch								f	F	F	F	F	●	●	●	●	4	8
PICH	green-tailed towhee					F	F	F	●	●	●	●	F	●	F	●	f	6	11
PIER	rufous-sided towhee					f	f	f	●	F	F	F	●	●	●	●	●	6	9
AMBE	sage sparrow						●	f	●	f	f	f	●	●	f	●	f	5	5
SPPA	chipping sparrow							f	F	F	F	F	●	●	●	●	●	5	9
SPBRE	Brewer's sparrow						●	f	●	f	f	f	●	F	f	●	f	4	5
NEMEL	song sparrow					F	●		●	F	F	F	●	F		F	●	4	11
	R	0	0	3	3	0	4	1	18	2	4	4	18	14	19	25	23		
	F	1	1	10	10	9	14	12	21	15	19	19	25	26	24	28	25		

Appendix 6. Life form 8: reproduces in shrubs; feeds in shrubs, trees, or air. (5 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
COAM	yellow-billed cuckoo																●	1	1
PSMI	bushtit					F	F	F	●	F	F	F	●	●	F	●	●	5	12
DEPE	yellow warbler					f	f	f	F	F	F	F	F	F	f	●	●	2	8
ICVI	yellow-breasted chat								F	F	F	F	f	●	f	●	●	3	7
CATR	American goldfinch					f	f	f	F	F	F	F	F	●	●	●	●	4	9
	R	0	0	0	0	0	0	0	1	0	0	0	1	3	1	4	5		
	F	0	0	0	0	1	1	1	4	4	4	4	3	4	2	4	5		

Appendix 6. Life form 9: reproduces primarily in deciduous trees; feeds in shrubs, trees, or air. (3 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
BOCE	cedar waxwing												F	F	●	●	●	3	5
ICGA	northern oriole												F		●	●	●	3	4
CAMEXI	house finch					f	f	f	F	F	F	F	●	●	●	●	●	5	9
	R	0	0	0	0	0	0	0	0	0	0	0	1	1	3	3	3		
	F	0	0	0	0	0	0	0	1	1	1	1	3	2	3	3	3		

Appendix 6. Life form 10: reproduces primarily in conifers; feeds in shrubs, trees, or air. (7 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
EMDI	western flycatcher						f	f	F	F	F	F	●	●	F	●	●	4	9
GYCY	pinyon jay								F	F	F	F	●	F	F	F	F	1	9
RECA	ruby-crowned kinglet								f	f	f	f	f	f	●	●	●	3	3
DECOR	yellow-rumped warbler								f	f	f	f	●	F	●	●	●	4	5
DENI	black-throated gray warbler								f	f	f	f	F	F	F	●	F	1	5
DETO	Townsend's warbler								f	f	f	f	f	f	f	f	●	1	1
PILU	western tanager								f	f	f	f	F	f	●	●	●	3	4
	R	0	0	0	0	0	0	0	0	0	0	0	3	1	3	5	5		
	F	0	0	0	0	0	0	0	2	2	2	2	5	4	6	6	7		

Appendix 6. Life form 11: reproduces in trees; feeds on ground, in shrubs, trees, or air. (13 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
ACGE	northern goshawk														●	F	●	2	3
ACST	sharp-shinned hawk			f	f				f	f	f	f	F	f	●	●	●	3	4
ACCO	Cooper's hawk			f	f				0	F	F	F	F	F	●	●	●	3	8
ZEMA	mourning dove	F	F	F	F	F	●	●	●	F	●	●	●	●	●	●	●	10	16
ASOT	long-eared owl								f	f	f	f	F	f	●	●	●	3	4
TYVE	western kingbird			f	f		f	f	●	F	F	F	F	F	●	●	●	4	9
COSO	western wood pewee						f	f	F	F	F	F	F	F	●	●	●	3	9
CYST	Steller's jay								F	F	F	F	●	●	●	●	●	5	9

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
COBRA	American crow	f	f	F	F	F	F	F	●	F	F	F	●	F	●	●	●	5	14
VIOL	red-eyed vireo														●	●	●	3	3
VIGI	warbling vireo														●	●	●	3	3
CAPU	purple finch	f	F	F	F	f	f	f	F	f	F	F	●	F	●	●	●	4	11
SPARB	American tree sparrow	f	F	F	F	f	f	f	F	f	F	F	●	F	●	●	●	4	11
	R	0	0	0	0	0	1	1	3	0	1	1	5	2	13	12	13		
	F	1	3	4	4	2	2	2	7	6	8	8	10	8	13	13	13		

Appendix 6. Life form 12: reproduces on very thick branches; feeds on ground or in water. (6 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
ARHE	great blue heron	f		F	F				0				R		R	R	●	4	3
CAAL	common egret	f		F	F				0				R		R	R	●	4	3
BUJA	red-tailed hawk	f	f	F	F	F	F	F	●	F	F	F	●	●	●	●	●	6	14
AQCH	golden eagle	F	F	F	F	F	F	F	●	F	F	F	●	●	F	F	●	4	16
PAHA	osprey																●	1	1
BUVIR	great horned owl	f	F	F	F	F	F	F	●	F	F	F	●	●	●	●	●	6	15
	R	0	0	0	0	0	0	0	3	0	0	0	5	3	4	4	6		
	F	1	2	5	5	3	3	3	3	3	3	3	3	3	3	3	6		

Appendix 6. Life form 13: reproduces – excavates own hole in a tree; feeds on ground, in shrubs, trees, or air. (9 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
COAU	common flicker					F		F	F	F	F	F	●	F	●	●	●	4	12
MELE	Lewis' woodpecker								f	f	f	f	0	f	●	●	●	3	3
SPVAR	yellow-bellied sapsucker												●		●	●	●	4	4
SPTH	Williamson's sapsucker												●		●	●	●	4	4
PIVI	hairy woodpecker												●		●	●	●	4	4
PIPU	downy woodpecker														●	●	●	3	3
PIAL	white-headed woodpecker														F	F	●	1	3
SICAR	white-breasted nuthatch												●		F	F	F	1	4
SICAN	red-breasted nuthatch												●		F	F	●	2	4
	R	0	0	0	0	0	0	0	0	0	0	0	6	0	6	6	8		
	F	0	0	0	0	1	1	1	1	1	1	1	6	1	9	9	9		

Appendix 6. Life form 14: reproduces in hole made by another species or that has occurred naturally; feeds on ground, in water, or air. (25 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
AISP	wood duck																●	1	1
BUIS	Barrow's goldeneye																●	1	1
MEMER	common merganser																●	1	1
FASP	American kestrel			F	F		F		F				●		●	●	●	4	8
TYAL	barn owl			F	F		F		F								●	1	5
OTAS	common screech owl			F	F		F		F				●	F	●	●	●	4	9
OTFL	flammulated owl														●	●		2	2
GLGN	pygmy owl			F	F		F		F				●	F	●	●	●	4	9
AEAC	saw-whet owl			f	f		f		f						●	●	●	3	3
CHVA	Vaux's swift			F	F	f	f	f	F	f	f	F	f	F	0	0	●	1	6
MYCI	ash-throated flycatcher			F	F	f	F	f	F	f	f	F	●	F	●	●	●	4	10
TATH	violet-green swallow			F	F		f		f			f		f	●	●	●	3	5
IRBI	tree swallow			F	F		f		f			f		f	●	●	●	3	5
PAATR	black-capped chickadee								f			F	●	F	●	●	●	4	6
CEFA	brown creeper								f			F	●	F	●	●	●	4	6
TRAE	house wren								F			f	●	●	●	●	●	5	6
SIME	western bluebird	f	f	F	F	F	F	F	F	F	F	F	●	F	●	●	●	4	14
SICU	mountain bluebird	f	f	F	F	F	F	F	F	F	F	F	●	F	●	●	●	4	14
STVU	European starling	f		F	F	f	f	f	F	F	f	f	●	f	●	●	●	4	8
PADO	house sparrow			F	F	f	f	f	F	f	f	f	f	f	●	●	●	3	6
	MAMMALS																		
MYYU	Yuma myotis					F	F	F	F	F	F	F	F	F			●	1	10
MYEV	long-eared myotis					F	F	F	F	F	F	F	F	F			●	1	10
MYVO	long-legged myotis					F	F	F	F	F	F	F	F	F			●	1	10
LANO	silver-haired bat					F	F	F	F	F	F	F	F	F			●	1	10
PRLO	raccoon								f				f				●	1	1
	R	0	0	0	0	0	0	0	0	0	0	0	10	1	15	15	24		
	F	0	0	12	12	6	11	6	15	7	6	10	14	13	15	15	24		

Appendix 6. Life form 15: reproduces – underground burrow; feeds on or near ground. (32 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	REPTILES																	R	F
SOSE	western ground snake					●	●	●	●									4	4
	BIRDS																		
ATCU	burrowing owl	●	f	F	F	●	●	F	●	F	f	f	f	f			F	4	9
	MAMMALS																		
SOME	Merriam shrew						●		●				●					3	3
EUMI	least chipmunk					0	●	●	●		●	●	0	●				6	6
EUQM	yellow pine chipmunk								●				●					2	2
AMLE	antelope ground squirrel					●		●										2	2
SPTO	Townsend ground squirrel	●			●				●								●	4	4
SPRI	Richardson ground squirrel								●									1	1
SPBE	Belding ground squirrel		●	●	0		●		●								●	5	5
SPCO	Columbian ground squirrel			●														1	1
SPLA	mantled ground squirrel						●		●		●	●	●	●				6	6
THTO	Townsend pocket gopher	●		●	●	●	●	●	●								●	8	8
THTA	northern pocket gopher	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	16	16
PELO	little pocket mouse					●												1	1
PEPA	Great Basin pocket mouse	0				●	●	●	●	0	0	0	●	0				5	5
MIME	dark kangaroo mouse					●												1	1
DIOR	Ord kangaroo rat	0				●		●	●									3	3
DIMI	chisel-toothed kangaroo rat					●		●	0									2	2
REME	western harvest mouse							●	●	●	0	0	●	0			●	5	5
PEMA	deer mouse	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	16	16
ONLE	northern grasshopper mouse					0	0		●				●					2	2
MIMO	montane vole		●	●	0			0	●				0		0	0	●	4	4
MILO	long-tailed vole		●	●	●			0	●				●				●	6	6
LACU	sage vole	●	●				●		●				●					5	5
ZAPR	western jumping mouse		●	●													●	3	3
CALAT	coyote	●	●	●	●	●	●	●	●	●	●	●	●	●			●	14	14
VUVU	red fox																●	1	1
VUMA	kit fox					●	●	●										3	3
MUER	short-tailed weasel		0														●	1	1
MUFR	long-tailed weasel	●	●	●	●	0	0	0	●	0	●	●	●	●	0	0	●	10	10
TATA	badger	f	0	f	f	f	●	f	●	f	f	f	●	f	f	f	●	4	4
MEMEP	striped skunk								●								●	2	2
	R	8	9	10	7	13	14	12	23	4	6	6	13	6	2	2	15		
	F	8	9	11	8	13	14	13	23	5	6	6	13	6	2	2	16		

Appendix 6. Life form 16: reproduces – underground burrow; feeds in water, on ground, or in air. (9 species)

Letter code	Species	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgr.	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountainmahogany/bunchgr.	curlleaf mountainmahogany/pinegr.	juniper/sagebrush/bunchgr.	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	Number of plant communities used by each species for: R	F
	BIRDS																		
MEAL	belted kingfisher																•	1	1
RIRI	bank swallow		f	F	F		f	f	F	f	f	f	f	f	F	F	•	1	6
STRU	rough-winged swallow		f	F	F		f	f	F	f	f	f	f	f	F	F	•	1	6
	MAMMALS																		
SOPR	Malheur shrew		•	•													•	3	3
SOVA	wandering shrew		•	•					•								•	4	4
CACAN	beaver																•	1	1
ONZI	muskrat																•	1	1
MUVI	mink								f								•	1	1
LUCA	river otter																•	1	1
	R	0	2	2	0	0	0	0	1	0	0	0	0	0	0	0	9		
	F	0	2	4	2	0	0	0	3	0	0	0	0	0	2	2	9		

Appendix 7. Wildlife orientation to structural conditions by life form. Life form 1: reproduces in water; feeds in water. (2 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
		bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass		
Letter code	Species																R	F
	AMPHIBIANS																	
RAPR	spotted frog		•			•			•			•			•		5	5
RACA	bullfrog		•			•			•			•			•		5	5
	R	2	2	0	0	2	0	0	2	0	0	2	0	0	2	0		
	F	2	2	0	0	2	0	0	2	0	0	2	0	0	2	0		

• – Primary (≥40%) reproduction and feeding
0 – Secondary (<40%) reproduction and feeding
R – Primary (≥40%) reproduction only
r – Secondary (<40%) reproduction only
F – Primary (≥40%) feeding only
f – Secondary (<40%) feeding only

Appendix 7. Life form 2: reproduces in water; feeds on ground, in shrubs, and/or trees. (6 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
		bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass		
	AMPHIBIANS																R	F
AMMA	long-toed salamander		•		R	F		R	F							•	4	3
SCIN	Great Basin spadefoot toad		•	F	•	F	F	•	F	F	R	F	F				4	10
BUBO	western toad		F	F	R	F		R	F		R	F	F		•	•	5	8
BUWO	Woodhouse toad		F	f	R	F		R	F		R	F	F		•		4	6
HYRE	Pacific treefrog		•	F	•	F	•	•	F	•	•	F	•	•	F	•	9	13
RAPI	leopard frog				R	F	F	R	F	F	R	F	F				3	6
	R	0	3	0	6	0	1	6	0	1	5	0	1	1	2	3		
	F	0	5	3	2	6	3	2	6	3	1	5	5	1	3	3		

Appendix 7. Life form 3: reproduces on ground around water or on floating or emergent vegetation; feeds in water, on ground, in shrubs, and trees. (44 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	REPTILES																	
THST	common garter snake	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	15	15
THEL	wondering garter snake	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	15	15
	BIRDS																	
POAU	horned grebe	F			F	R		F	R		F			F	R		3	5
PONIGR	eared grebe	F			F	R		F	R		F			F	R		3	5
AEOC	western grebe		R			R			R						R		4	0
POPO	pied-billed grebe	F	R		F	R		F	R		F	R		F	R		5	5
PHAU	double-crested cormorant				R	R	R	R	R	R							6	0
BOLE	American bittern	F	•		F	•		F	•		F	•		F	•		5	10
IXEX	least bittern	F	•		F	•		F	•		F	•		F	•		5	10
BRCA	Canada goose		•	f		•	f										2	2
ANPL	mallard		F			•	•		•	•		0	•		•	•	7	8
ANSTR	gadwall		F			•	•		•	•		0	•		•	•	7	8
ANAC	common pintail		F			•	•		•	•		0	•		•	•	7	8
ANCR	green-winged teal		F			•	•		•	•		0	•		•	•	7	8
ANDIS	blue-winged teal		F			•	•		•	•		0	•		•	•	7	8
ANCY	cinnamon teal		F			•	•		•	•		0	•		•	•	7	8
ANAMEO	American wigeon		F			•	•		•	•		0	•		•	•	7	8
ANCL	northern shoveler		F			•	•		•	•		0	•		•	•	7	8
AYAM	redhead		•														1	1
AYCO	ring-necked duck		F			•	0		0	0		0	0		•	0	2	3
AYVA	canvasback		•														1	1
AYAF	lesser scaup		F												•		1	2

Letter code	Species	Structural conditions: Grass-forb, bare ground	Grass-forb, annuals	Grass-forb, bunchgrass	Low shrub, bare ground	Low shrub, annuals	Low shrub, bunchgrass	Tall shrub, bare ground	Tall shrub, annuals	Tall shrub, bunchgrass	Tree, bare ground	Tree, annuals	Tree, bunchgrass	Tree/shrub, bare ground	Tree/shrub, annuals	Tree/shrub, bunchgrass	R	F
OXJA	ruddy duck		F												●		1	2
GRCA	sandhill crane		●			F											1	2
RALI	Virginia rail		F			●	f		●	f			f		●	f	3	4
POCAR	sora		F			●			●						●		3	4
FUAM	American coot		F			●			●			0			●		3	4
CHALE	snowy plover	●	F														1	2
CHVO	killdeer	●	●		●	f		●	f		●	f		●	f		6	6
CAGA	common snipe	F	●	f		●			●			0			0		3	4
ACMA	spotted sandpiper	F	●	●	F	●	f	F	●	f							4	7
TRME	greater yellowlegs		●														1	1
REAM	American avocet	F	●	f	F	f	f	F	f	f							1	4
HIME	black-necked stilt	F	●		F	●		F	●								3	6
STTRI	Wilson's phalarope	F	●		F	●		F	●								3	6
LACA	California gull	F	●	F	F	●	f	f	f	f	f	f	f	f	f	f	2	5
LAPI	Franklin's gull	F	●	F	F	●	f	f	f	f	f	f	f	f	f	f	2	5
STFO	Forster's tern	F	●	F	F	●											2	5
STCAS	Caspian tern	F	●	F	F	●											2	5
CHNI	black tern	F	●	F	F	●											2	5
CIME	dipper	F	●		F	●		F	●					●	●	F	5	9
CIPA	marsh wren		●			●			●			●			●		5	5
GETR	common yellowthroat		F		F	●		F	●			F			F		2	7
XAXA	yellow-headed blackbird		●			●			●			0			●		4	4
	R	4	25	3	4	35	11	4	28	11	3	6	10	4	25	10		
	F	20	39	8	19	30	10	14	23	10	8	6	10	9	22	11		

Appendix 7. Life form 4: reproduces on cliffs, caves, rims and/or talus; feeds on ground or in air. (33 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	REPTILES																	
CRCO	collared lizard	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	15	15
SCOC	western fence lizard	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	15	15
	BIRDS																	
CAAU	turkey vulture	•	F	F	•	F	F	•	F	F	•	F	F	•	F	F	5	15
BUREG	ferruginous hawk	f	F	•	f	•	•	f	•	•	f	•	•	f	•	•	9	10
FAME	prairie falcon	f	•	•	f	•	•	f	•	•	f	•	•	f	•	•	10	10
ALCH	chukar	f	F	•	f	F	•	f	F	•	f	F	F	f	F	F	3	10
COLI	rock dove		•	R		•	R		F	F		F	F		F	F	4	8
CYNI	black swift	f	F	•	f	F	•	f	F	•	f	F	•	f	F	•	5	10
AESA	white-throated swift	f	F	•	f	F	•	f	F	•	f	F	•	f	F	•	5	10
SASA	Say's phoebe		F	•		F	•		F	•		F	•		F	•	5	10
HIRU	barn swallow		F	•		F	•		F	•		F	•		F	•	5	10
PEPY	cliff swallow		F	•		F	•		F	•		F	•		F	•	5	10
COCOR	common raven	F	•	•	F	•	•	F	•	•	F	•	•	F	•	•	10	15
CAMEXO	canyon wren		•	•		•	•		•	•		•	•		•	•	10	10
SAOB	rock wren		•	•		•	•		•	•		•	•		•	•	10	10
LEAT	black rosy finch		•	•		F	F		F	F		F	F		F	•	3	10
	MAMMALS																	
MYLU	little brown myotis		•	•		•	•		•	•	F	•	•	F	•	•	10	12
MYTH	fringed myotis		•	•		•	•		•	•	F	•	•	f	•	•	10	11
MYCA	California myotis		•	•		•	•		•	•	f	•	•	F	•	•	10	11
MYLE	small-footed myotis		•	•		•	•		•	•	f	•	•	f	•	•	10	10
PIHE	western pipistrelle		•	•		•	•		•	•	f	•	•	F	•	•	10	11
EPFU	big brown bat		•	•		•	•		•	•	F	•	•	f	•	•	10	11
EUMAC	spotted bat	f	•	•	f	•	•										4	4
PLTO	western big-eared bat		•	•	F	•	•	F	•	•	f	•	•	F	•	•	10	13
ANPA	pallid bat		•	•	F	•	•	F	•	•	f	•	•	f	•	•	10	12
MAFL	yellow-bellied marmot		•	•		0	0		•	•		0	0		0	0	4	4
PECR	canyon mouse	•	•	•		0	0	f	•	•	•	•	•	•	•	•	11	11
NELE	desert woodrat	•	•	•		0	0		•	•	•	•	•	•	•	•	11	11
NECI	bushy-tailed woodrat	•	•	•		0	0		•	•	•	•	•	•	•	•	11	11
ERDO	porcupine		F	F		f	f		F	F		•	•		•	•	4	8
SPPU	spotted skunk	•	•	•	0	0	0	•	•	•	F	•	•	F	•	•	10	12

Letter code	Species		Structural conditions: Grass-forb, bare ground	Grass-forb, annuals	Grass-forb, bunchgrass	Low shrub, bare ground	Low shrub, annuals	Low shrub, bunchgrass	Tall shrub, bare ground	Tall shrub, annuals	Tall shrub, bunchgrass	Tree, bare ground	Tree, annuals	Tree, bunchgrass	Tree/shrub, bare ground	Tree/shrub, annuals	Tree/shrub, bunchgrass	R	F
FECO	cougar		f	f	f	f	f	f	f	●	●	f	●	●	f	●	●	6	6
LYRU	bobcat		f	f	f	f	f	f	f	●	●	f	●	●	f	●	●	6	6
		R	7	22	29	3	17	23	4	22	28	6	22	27	6	22	28		
		F	8	31	30	6	25	24	7	32	32	11	31	31	12	31	31		

Appendix 7. Life form 5: reproduces on ground without specific water, cliff, rim or talus association; feeds on ground. (45 species)

Letter code	Species	Structural conditions: Grass-forb, bare ground	Grass-forb, annuals	Grass-forb, bunchgrass	Low shrub, bare ground	Low shrub, annuals	Low shrub, bunchgrass	Tall shrub, bare ground	Tall shrub, annuals	Tall shrub, bunchgrass	Tree, bare ground	Tree, annuals	Tree, bunchgrass	Tree/shrub, bare ground	Tree/shrub, annuals	Tree/shrub, bunchgrass	R	F
	REPTILES																R	F
CRWI	leopard lizard	●	●	0	●	●	0	●	●	0	●	0	0	●	0	0	8	8
SCGR	sagebrush lizard				F	●	●	F	●	●	f	●	●	f	●	●	8	10
UTST	side-blotched lizard	F		F	F	●	●	F	●	●	F	●	●	F	●	●	8	14
PHPL	desert horned lizard	F		●	f	●	●	f	●	●	f	●	●	f	f	0	7	8
PHDO	short-horned lizard	F		●	f	●	●	f	●	●	f	●	●	f	●	0	7	8
EUSK	western skink			0		F	●		F	●		F	●		F	●	4	8
CNTI	western whiptail	0	0		●	●	0	●	●	0	●	0	0	●	0	0	6	6
CHBO	rubber boa				f	●	●	f	●	●	F	●	●	F	●	●	8	10
COCONS	yellow-bellied racer		0	0	f	●	●	f	●	●	f	●	●	f	●	●	8	8
MATA	striped whipsnake		F	F		●	●		●	●		●	●		●	●	8	10
PIME	gopher snake		F	0	F	●	●	F	●	●		0	0		0	0	4	7
HYTO	night snake	●	F		●	F		●	F		●	F		●	F		5	10

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
CRVI	western rattlesnake		F	●		F	●		F	●		F	●		F	●	5	10
CICY	northern harrier		●	0		●	F								●	F	3	5
DEOB	blue grouse					●	F		●	F					●	F	3	6
BOUM	ruffed grouse					●	F		●	F		●	F		●	F	4	8
CEUR	sage grouse					●	●		●	●		●	●		●	●	8	8
LOCA	California quail					●			●						●		3	3
ORPI	mountain quail					●	F		●	F		●	F		●	F	4	8
PEPER	gray partridge	F	●	F	F	●	F										2	6
PHCOL	ring-necked pheasant		●			●			●						●		4	4
NUAM	long-billed curlew		●	●		●	●		●	●		F	F		F	F	6	10
ASFL	short-eared owl		●	F		●	F		F	F		F	F		F	F	2	10
ERAL	horned lark	●	●	●	●	F	●		F	F		F	F				5	10
CAFU	veery					●			●						●		3	3
WIPU	Wilson's warbler					●			●						●		3	3
DOOR	bobolink		●			●			●			●			●		5	5
STNEG	western meadowlark		●	●		F	F		F	F		F	F		F	F	2	10
PASA	savannah sparrow		●	●		●	●		F	F		F	F		F	F	4	10
AMSA	grasshopper sparrow		●	●		●	●		F	F		F	F		F	F	4	10
POGRA	vesper sparrow		●	●		●	●		F	f							4	6
CHGR	lark sparrow		F	F		F	●		●	●		F	F		F	●	4	10
JUHY	northern junco		F	F		●	●		●	●		●	●		●	●	8	10
	MAMMALS																	
SYID	pygmy rabbit					f	0		●	●					●	●	4	4
SYNU	mountain cottontail					0	0		●	●		0	0		●	●	4	4
LETO	white-tailed jackrabbit		F	F		f	●		●	●	f	F	F	f	●	●	5	9
LECA	black-tailed jackrabbit		F	F		f	0		●	●	f	F	F	f	●	●	4	8
RARA	black rat					0	0		●	●					●	●	4	4
RANO	Norway rat					0	0		●	●					●	●	4	4
FECA	feral house cat		F	F		F	F		●	●		F	F		●	●	4	10
EQUA	feral horse		●	●		0	0		●	●		●	●		●	●	8	8
CEEL	elk					f	f		f	f		F	F		●	●	2	4
ODHE	mule deer		F	F		F	0		F	●		F	F		F	●	2	9
ANAMER	pronghorn		F	F		F	●		F	●		F	F		F	●	3	10
OVCA	bighorn sheep		F	●		F	0		F	●		F	●		F	F	3	9
	R	3	14	12	4	27	20	3	30	25	3	13	13	3	26	21		
	F	7	25	22	8	37	28	6	42	34	5	30	28	5	38	31		

Appendix 7. Life form 6: reproduces on ground; feeds in shrubs, trees, or air. (4 species)

			Structural conditions																
			Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species		bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																		
PHNU	poorwill			F	F	F	●	F	F	●	F							2	8
CHMI	common nighthawk		f	F	F	F	●	●	F	●	●	F	●	●	F	●	●	8	14
MYTO	Townsend's solitaire						●	●		●	●		●	●		●	●	8	8
VECE	orange-crowned warbler						●			●			●			●		4	4
		R	0	0	0	0	4	2	0	4	2	0	3	2	0	3	2		
		F	0	2	2	2	4	3	2	4	3	1	3	2	1	3	2		

Appendix 7. Life form 7: reproduces in shrubs; feeds on ground, in water or air. (29 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
BUST	green heron		F	F		F	F							R	R	R	3	4
BUIB	cattle egret		F						●			●			●		3	4
NYNY	black-crowned night heron								●			●			●		3	3
BUSW	Swainson's hawk		F	F		F	F		●	●		●	●		●	●	6	10
STCAL	calliope hummingbird		F			F			●			●			●		3	5
CAAN	Anna's hummingbird		F						●			●			●		3	4
TYTY	eastern kingbird						F		●	F		●	F		●	F	3	7

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
EMTR	willow flycatcher					F	F		●	●		●	●		●	●	6	8
EMWR	gray flycatcher								●	●		●	●		●	●	6	6
APCO	scrub jay								●	●		F	F		●	●	4	6
PIPI	black-billed magpie		F	F		F	F		●	●		●	●		●	●	6	10
DUCA	gray catbird					F	F		●	●		f	f		●	●	4	6
TORV	brown thrasher					F	F		●	●					●	●	4	6
ORMO	sage thrasher								●	●					●	●	4	4
TUMI	American robin		F			F	f		●	●		●	●		●	●	6	8
CAUS	Swainson's thrush								●	●		F	F		●	●	4	6
PACAE	blue-gray gnatcatcher								●	●		●	●		●	●	6	6
LALU	loggerhead shrike					F	F		F	●		●	●		●	●	5	8
AGPH	red-winged blackbird		●			●			●			●			●		5	5
EUCY	Brewer's blackbird		●			●			●			●			●		5	5
MOAT	brown-headed cowbird		●			●			●			●	●		●	●	7	7
PAAMO	lazuli bunting								●	●		F	F		●	●	4	6
CAPS	lesser goldfinch					F	F		●	●		F	F		F	F	2	8
PICH	green-tailed towhee					●	●		●	●					●	●	6	6
PIER	rufous-sided towhee					●	●		●	●					●	●	6	6
AMBE	sage sparrow								●	●		F	F		●	●	4	6
SPPA	chipping sparrow								●	●		●	●		●	●	6	6
SPBRE	Brewer's sparrow					●	●		●	●		F	F		●	●	6	8
NEMEL	song sparrow								●	●					●	●	4	4
	R	0	3	0	0	6	3	0	27	20	0	16	9	1	28	21		
	F	0	10	3	0	16	12	0	28	21	0	22	16	0	28	22		

Appendix 7. Life form 8: reproduces in shrubs; feeds in shrubs, trees, or air. (5 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
COAM	yellow-billed cuckoo								•	•		0	0		•	•	4	4
PSMI	bushtit					F	F		•	•	f	F	F	f	•	•	4	8
DEPE	yellow warbler								•	•		•	•		•	•	6	6
ICVI	yellow-breasted chat								•	•					•	•	4	4
CATR	American goldfinch					F	F		•	•		•	•		•	•	6	8
	R	0	0	0	0	0	0	0	5	5	0	2	2	0	5	5		
	F	0	0	0	0	2	2	0	5	5	0	3	3	0	5	5		

Appendix 7. Life form 9: reproduces primarily in deciduous trees; feeds in shrubs, trees, or air. (3 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
BOCE	cedar waxwing								•	0	0	F	F	0	•	•	3	5
ICGA	northern oriole					f	f		•	F		•	F		•	•	4	6
CAMEXI	house finch					f	f		F	f		F	f		•	•	2	4
	R	0	0	0	0	0	0	0	2	0	0	1	0	0	3	3		
	F	0	0	0	0	0	0	0	3	1	0	3	2	0	3	3		

Appendix 7. Life form 10: reproduces primarily in conifers; feeds in shrubs, trees, or air. (7 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
EMDI	western flycatcher				f	F	F		●	●	f	●	●	f	●	●	6	8
GYCY	pinyon jay					f	f	f	●	●	f	●	●	f	●	●	6	6
RECA	ruby-crowned kinglet								f	f	f	●	f	f	●	f	2	2
DECOR	yellow-rumped warbler					f	f		0	f	f	●	f	f	●	f	2	2
DENI	black-throated gray warbler								f	f	f	F	F	f	●	●	2	4
DETO	Townsend's warbler								f	f	f	f	f	f	●	f	1	1
PILU	western tanager								F	F	F	●	F	F	●	F	2	8
	R	0	0	0	0	0	0	0	2	2	0	5	2	0	7	3		
	F	0	0	0	0	1	1	0	3	3	1	6	4	1	7	4		

Appendix 7. Life form 11: reproduces in trees; feeds on ground, in shrubs, trees, or air. (13 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
ACGE	northern goshawk											F	●		F	●	2	4
ACST	sharp-shinned hawk					f	f		F	f	f	F	f	f	●	●	2	4
ACCO	Cooper's hawk					F	F		F	F	f	●	●	f	●	●	4	8
ZEMA	mourning dove		F	f		0	F		●	R	R	●	R	R	●	R	8	5
ASOT	long-eared owl					f	f		f	f		●	0		●	●	3	3
TYVE	western kingbird					F			●			●		0	●	●	4	5
COSO	western wood pewee					F	f		F	f	f	●	f	f	●	●	3	5

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/ shrub				
		bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
CYST	Steller's jay					f	f		F	f	f	•	f	F	•	•	3	5
COBRA	American crow		F	f		F	f		F	f	0	•	0	R	•	R	4	5
VIOL	red-eyed vireo					f			0	f	f	0	f	f	•	f	1	1
VIGI	warbling vireo					f			0	f	f	•	f	0	•	0	2	2
CAPU	purple finch		F			f			f		f	•	f	0	•	0	2	3
SPARB	American tree sparrow		F			F			F	F	0	•	F	0	•	F	2	8
	R	0	0	0	0	0	0	0	2	1	1	10	3	2	13	9		
	F	0	4	0	0	5	2	0	8	2	0	12	3	1	13	8		

Appendix 7. Life form 12: reproduces on very thick branches; feeds on ground or in water. (6 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/ shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																R	F
ARHE	great blue heron	f	F	f					R		R	R	R	R	R	R	7	1
CAAL	common egret	f	F	f					R		R	R	R	R	R	R	7	1
BUJA	red-tailed hawk	f	F	F	f	F	F	f	F	F	R	•	•	R	•	•	6	10
AQCH	golden eagle	f	F	F	f	F	F	f	F	F	R	•	•	R	•	•	6	10
PAHA	osprey												R			R	2	0
BUVIR	great horned owl	f	F	F	f	F	F	f	F	F	R	•	•	R	•	•	6	10
	R	0	0	0	0	0	0	0	2	0	5	5	6	5	5	6		
	F	0	5	3	0	3	3	0	3	3	0	3	3	0	3	3		

Appendix 7. Life form 13: reproduces – excavates own hole in a tree; feeds on ground, in shrubs, trees, or air. (9 species)

			Structural conditions																
			Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species		bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																		
COAU	common flicker		f	F	f	f	F	f	f	F	f	●	●	●	●	●	●	6	9
MELE	Lewis' woodpecker					f	F	f	f	f	f	●	●	●	●	●	●	6	8
SPVAR	yellow-bellied sapsucker									F	f	0	●	0	●	●	●	4	5
SPTH	Williamson's sapsucker									F	f	0	●	0	●	●	●	4	5
PIVI	hairy woodpecker									f			0	0	0	●	●	2	2
PIPU	downy woodpecker									F	f	0	●	0	0	●	●	3	4
PIAL	white-headed woodpecker									f	f	0	●	0	0	●	●	3	3
SICAR	white-breasted nuthatch									f	f	●	●	●	●	●	●	6	6
SICAN	red-breasted nuthatch									f	f	●	●	●	●	●	●	6	6
		R	0	0	0	0	0	0	0	0	0	4	8	4	6	9	9		
		F	0	1	0	0	2	0	0	5	0	4	8	4	6	9	9		

Appendix 7. Life form 14: reproduces in a hole made by another species or that has occurred naturally; feeds on ground, in water, or air. (25 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
		bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
AISP	wood duck											R	R		R	R	4	0
BUIS	Barrow's goldeneye											R	R		R	R	4	0
MEMER	common merganser											0			•		1	1
FASP	American kestrel	f	F	f	f	F	f	f	F	f	0	•	•	•	•	•	5	8
TYAL	barn owl	f	F	f	f	f	f	f	F	f	0	•	•	0	•	•	4	6
OTAS	common screech owl	f	F	f	f	f	f	f	F	f	0	•	•	0	•	•	4	6
OTFL	flammulated owl												•			•	2	2
GLGN	pygmy owl	f	F	f	f	f	f	f	F	f	0	•	•	0	•	•	4	6
AEAC	saw-whet owl					f			F			•	0		•	•	3	4
CHVA	Vaux's swift	f	F	f	f	F	F	f	F	F	0	•	•	0	•	•	4	9
MYCI	ash-throated flycatcher					F	F		F	F	•	0	•	•	0	•	4	8
TATH	violet-green swallow	f	F	f	f	F	f	f	F	f	R	0	0	R	0	0	2	3
IRBI	tree swallow	f	F	f	f	F	f	f	F	f	R	0	0	R	0	0	2	3
PAATR	black-capped chickadee								F		0	•	0	0	•	0	2	3
CEFA	brown creeper								f		0	•	0	0	•	0	2	2
TRAE	house wren					f			F		0	•	0	0	•	0	2	3
SIME	western bluebird	f	F	F	f	F	F	f	F	F	•	•	•	•	•	•	6	12
SICU	mountain bluebird	f	F	F	f	F	F	f	F	F	•	•	•	•	•	•	6	12
STVU	European starling	f	F	F	f	F	F	f	F	F	0	•	0	0	•	0	2	8
PADO	house sparrow	f	f	f	f	F	F	f	F	F	0	•	0	0	•	0	2	6
	MAMMALS																	
MYYU	Yuma myotis				f	f	F	f	f	F	•	•	•	•	•	•	6	8
MYEV	long-eared myotis				f	f	F	f	f	F	•	•	•	•	•	•	6	8
MYVO	long-legged myotis						F			F				•	•	•	3	5
LANO	silver-haired bat						F			F	•	•	•	•	•	•	6	8
PRLO	raccoon	f	F	f	f	F	F	f	F	F	f	•	•	f	•	•	4	9
	R	0	0	0	0	0	0	0	0	0	8	19	15	10	21	17		
	F	0	11	3	0	10	11	0	16	11	6	17	13	8	19	15		

Appendix 7. Life form 15: reproduces underground in burrow; feeds on or under ground. (32 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	REPTILES																	
SOSE	western ground snake	F	●	●	F	●	●	F	0	0	F	0	0				4	8
	BIRDS																	
ATCU	burrowing owl	f	●	●	f	●	●		0	0		0	0		f	f	4	4
	MAMMALS																	
SOME	Merriam shrew			●			●			●			●			●	5	5
EUMI	least chipmunk					f	0		F	●		f	●		F	●	3	5
EUQM	yellow pine chipmunk											●	●		●	●	4	4
AMLE	antelope ground squirrel					0	●		0	●							2	2
SPTO	Townsend ground squirrel			●		0	●		0	0			●		0	●	4	4
SPRI	Richardson ground squirrel			0		●	●		0	0					0	0	2	2
SPBE	Belding ground squirrel		●	●		●	●		0	0							4	4
SPCO	Columbian ground squirrel		●	●													2	2
SPLA	mantled ground squirrel			0		F	●		f	●		F	●		f	●	4	6
THTO	Townsend pocket gopher		●	●		●	●		0	0		●	●		●	●	8	8
THTA	northern pocket gopher		●	●		●	●		●	●		●	●		●	●	10	10
PELO	little pocket mouse			0		●	●		0	0							2	2
PEPA	Great Basin pocket mouse			0		0	0		●	●		●	●		●	●	6	6
MIME	dark kangaroo mouse			0		●	●		0	0							2	2
DIOR	Ord kangaroo rat		0	0		0	0		●	●		●	●		●	●	6	6
DIMI	chisel-toothed kangaroo rat		0	0		0	0		●	●					0	0	2	2
REME	western harvest mouse			0		0	0		●	●		●	●		●	●	6	6
PEMA	deer mouse	f	0	0	f	0	0		●	●	f	●	●	f	●	●	6	6
ONLE	northern grasshopper mouse	f	f	0	f	0	0		●	●		●	●		●	●	6	6
MIMO	montane vole		0	●		0	0		●	●		0	●		0	●	5	5
MILO	long-tailed vole		0	●		0	●		●	●		0	●		0	●	6	6
LACU	sage vole		F	●		F	●		●	●		f	●		F	●	6	9
ZAPR	western jumping mouse		0	●		0	●		0	●		0	●		0	●	5	5
CALAT	coyote	f	F	F	f	f	●		f	●	f	●	●	f	●	●	6	8
VUVU	red fox					F									●	●	2	3
VUMA	kit fox					F	●		F	●							2	4
MUER	short-tailed weasel											F	0		●	●	2	3
MUFR	long-tailed weasel		F	0		0	0		●	●		●	●		●	●	6	7
TATA	badger		f	f		0	0		●	●		●	●		●	●	6	6
MEMEP	striped skunk		f			0	f		●	F		F	F		●	●	3	6
	R	0	6	12	0	8	17	0	13	19	0	11	19	0	14	22		
	F	1	9	13	1	12	17	1	15	20	1	14	20	0	16	22		

Appendix 7. Life form 16: reproduces underground in burrow; feeds in water, on ground, or in air. (9 species)

		Structural conditions																
		Grass-forb			Low shrub			Tall shrub			Tree			Tree/shrub				
Letter code	Species	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	bare ground	annuals	bunchgrass	R	F
	BIRDS																	
MEAL	belted kingfisher					R	R		R	R					R	R	6	0
RIRI	bank swallow		F			•	•		•	•		•	•		•	•	8	9
STRU	rough-winged swallow		F			•	•		•	•		•	•		•	•	8	9
	MAMMALS																	
SOPR	Malheur shrew		0	•		0	•		0	•		0	•		0	•	5	5
SOVA	wandering shrew		0	•		0	•		0	•		0	•		0	•	5	5
CACAN	beaver					f	0		f	0		•	•		•	•	4	4
ONZI	muskrat					0	0		•	•		F			•	•	4	4
MUVI	mink		F			0	0		•	•		F			•	•	4	4
LUCA	river otter		F			0	0		•	•		F			•	•	4	4
	R	0	0	2	0	3	5	0	5	8	0	3	5	0	7	9		
	F	0	4	2	0	2	4	0	5	7	0	6	5	0	6	8		

Appendix 8. Composite occurrence and orientation list for 341 wildlife species in southeastern Oregon.

Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Letter code	Life form number	Species	Versatility rating	Activity/seasonal occurrence: January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
		AMPHIBIANS															
AMMA	2	long-toed salamander	L													approx. 50 eggs/♀	h.r. ≤30.5 m (100 ft)/adult
SCIN	2	Great Basin spadefoot	L													≥ 100/♀	strong homing response; density 300-900/ac
BUBO	2	western toad	L													100 + eggs/♀	h.r. approx. 16.2 m^2 (174.3 ft^2)/adult
ODHE	5	mule deer	M													1-2 fawns	
ANAMER	5	pronghorn	L													1-3; avg. 2 kids	
OVCA	5	bighorn sheep	L													1-2; avg. 1 lamb	
FECO	4	cougar	M													1-5; avg. 3; 1 litter	6,475 ha (16,000 ac)
FECA	5	feral house cat	L													4-6; 1 + litters	
LYRU	4	bobcat	M													1-6; avg. 3-4; 1 litter	518 ha (1,280 ac)
EQCA	5	feral horse	L													1-2; avg. 1 foal	

NOTE: See footnotes at end of appendix 8, p. 138.

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
one 0.8-ha (2-ac) pond/ population			● ■			○ □										● ■	● ■	● ■	● ■	● ■		● ■	0
≥2.0 ha (5 ac)/population	● ■		■	■			□	● ■	□	■	■	□	□	■	□	● ■	● ■	● ■	● ■	● ■		● ■	-
≥25.0 ha (62 ac)/population	□	■	■	■	□	○	□	● ■	■	□	□	□	□	■	■	● ■	● ■	● ■	● ■	● ■		● ■	0
	□	■	■	■	■	■	■	● ■	■	● ■	● ■	● ■	● ■	□	■	■	■	■	■	□	□	○ □	-
	● ■				■	● ■	■	● ■	■	■	■	■	■			■	□	■		■	□		-
	□	■	■	■	■	■	□	■	□	● ■	● ■	□	● ■	□	□	■	■	■	□	□	■	○ □	-
		■						● ■		● ■	● ■	● ■	● ■	■	■	■	■	□		□	■	○ □	-
							● ■					● ■		■	■	● ■	● ■	● ■	□	○ □	○ □		+
		■	■	■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	○ □	○ □	○ □	○ □	-
			● ■	● ■	○ □	○ □	■	● ■	○ □	○ □	○ □	● ■	○ □	○ □	○ □	○ □	○ □	○ □	○ □	○ □	○ □		+

Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CECAN	5	elk	L													1-2 calves	
MUVI	16	mink	L													2-10; avg. 4; 1 litter	1.6 stream km (1 stream mi)
TATA	15	badger	L													2-5; 1 litter	
SPPU	4	spotted skunk	M													1.5; 1 litter	≥259 ha (640 ac)
MEMEP	15	striped skunk	L													2-10; avg. 6-7; 1 litter	17-38 ha (43-95 ac)
LUCA	16	river otter	L													1-5; avg. 2-3; 1 litter	80 stream km (50 stream mi)
VUVU	15	red fox	L													2-10; avg. 5-6; 1 litter	259-777 ha (640-1,920 ac)
VUMA	15	kit fox	L														
PRLO	14	raccoon	L													1-7; avg. 2-3; 1 litter	449 ha (1,110 ac)
MUER	15	short-tailed weasel	L													4-13; avg. 6-7; 1 litter	
MUFR	15	long-tailed weasel	M													4-9; avg. 6-8; 1 litter	approx. 259 ha (640 ac)

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
										■	■	■	■	● ■	● ■	● ■	● ■	○ □			● ■		-
1.6 stream km (1 stream mi)/ pair								□								● ■	● ■	● ■	● ■	● ■	● ■	○ □	0
	□	○ □	□	□	□	● ■	□	● ■	□	□	□	● ■	□	□	□	● ■	○ □	● ■		● ■	○ □	○ □	+
≥259 ha (640 ac)/pair								● ■				● ■				● ■	● ■		○ □	● ■		○ □	0
≥259 ha (640 ac)/pair								● ■								● ■	● ■			● ■		○ □	0
≥80 stream km (50 stream mi)/ pair																● ■	● ■	● ■	□	● ■	● ■	○ □	0
518-777 ha (1,280-1,920 ac)/ pair																● ■	● ■		■	● ■		○ □	+
					● ■	● ■	● ■															● ■	+
3.2 stream km (2 stream mi)/ pair								□				□				● ■	● ■	● ■	□	○ □	○ □	○ □	0
		○ □														● ■	● ■				● ■		0
259 ha (640ac)/pair	● ■	● ■	● ■	● ■	○ □	○ □	○ □	● ■	○ □	● ■	● ■	● ■	● ■	○ □	○ □	● ■	● ■	● ■	● ■	● ■	● ■	○ □	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)

L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
RARA	5	black rat	L														
RANO	5	Norway rat	L													6-22; avg. 6-8; 8 litters	
ZAPR	15	western jumping mouse	L													2-7; 1 litter	
ERDO	4	porcupine	L													1 young	101-146 ha (250-360 ac)
CALAT	15	coyote	M													4-19; avg. 5-7; 1 litter	
NECI	4	bushy-tailed woodrat	M													1-6; avg. 2-4; 1 litter	
MIMO	15	montane vole	L													2-8; avg. 5-6; 4 + litters	
MILO	15	long-tailed vole	L													2-10; avg. 3-6	
LACU	15	sage vole	L													2-13; avg. 4-6; 4 + litters	
ONZI	16	muskrat	L													2-16; avg. 6-8; 2 litters	
REME	15	western harvest mouse	M													1-9; avg. 2-4; 1 + litters	
PECR	4	canyon mouse	M													3-5; 1 + litters	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
								● ■						● ■	● ■	● ■	● ■			● ■			+
								● ■						● ■	● ■	● ■	● ■			● ■			+
16 ha (40 ac)/population		● ■	● ■													● ■	● ■	● ■	● ■	● ■	● ■	○ □	-
2,590 ha (6,400 ac)/ population		□	□	□				● ■		● ■	● ■	● ■	● ■	□	□	● ■	● ■		■	○ □	○ □	○ □	-
	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■			● ■	● ■	● ■	□	□	□	○ □	-
32 ha (80 ac)/population					■	■	■	● ■	■	■	■	● ■	■									● ■	+
8 ha (20 ac)/population		● ■	● ■	○ □			○ □	● ■				○ □		○ □	○ □	● ■	● ■	● ■	● ■	● ■	● ■		0
16 ha (40 ac)/population		● ■	● ■	● ■			○ □	● ■				● ■				● ■	● ■	● ■	● ■	● ■	● ■	○ □	0
16 ha (40 ac)/population	● ■	● ■				● ■		● ■				● ■										○ □	0
1.6 stream km (1 stream mi)/ population																● ■	● ■	● ■	● ■	● ■	○ □		0
16 ha (40 ac)/population							● ■	● ■	● ■	○ □	○ □	● ■	○ □			● ■	● ■	● ■	● ■	● ■	● ■	○ □	+
0.8 km (0.5 mi) cliff/ population								● ■				● ■				● ■	● ■			○ □	○ □	● ■	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
■, □ Secondary (<40%)
L – Low
M – Medium
H – High

Letter code	Life form number	Species	Versatility rating	Activity/seasonal occurrence (January, February, March, April, May, June, July, August, September, October, November, December)	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PEMA	15	deer mouse	M		1-9; avg. 3-5; ± 6 litters	greasewood ♂ 372 m², ♀ 299 m²; big sage ♂ 372 m², ♀ 392 m²
ONLE	15	northern grasshopper mouse	L		4-6; 1 + litters	
NELE	4	desert woodrat	M			
PEPA	15	Great Basin pocket mouse	L		3-8; avg. 5-6; 1-2 litters	greasewood ♂ 288 m², ♀ 278 m²; big sage ♂ 337 m², ♀ 267 m²
MIME	15	dark kangaroo mouse	L			
DIOR	15	Ord kangaroo rat	L		1-6; avg. 4; 1-2 litters	
DIMI	15	chisel-toothed kangaroo rat	L			
CACAN	16	beaver	L		1-9; avg. 2-4; 1 litter	
SPCO	15	Columbian ground squirrel	L		2-7; avg. 3-4; 1-2 litters	
SPLA	15	mantled ground squirrel	L		4-8; avg. 5-6; 1-2 litters	
THTO	15	Townsend pocket gopher	M		3-8; 1-2 litters	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
≥16 ha (40 ac)/population	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	○□	+
32 ha (80 ac)/population					□□	□□		■■				■■										□□	-
					●■	●■	●■	●■														○□	+
16 ha (40 ac)/population	○□				●■	●■	●■	●■	○□	○□	○□	●■	○□									○□	0
					●■																	●■	0
32 ha (80 ac)/population	○□				●■		●■	●■														○□	0
					●■		●■	○□														○□	0
1.6 stream km (1 stream mi)/ colony																●■	●■	●■		●■	○□		-
32 ha (80 ac)/population			●■																				0
16 ha (40 ac)/population						●■		●■		●■	●■	●■	●■									●■	+
16 ha (40 ac)/population	●■		●■	●■	●■	●■	●■	●■								●■		●■		●■			+

Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
THTA	15	northern pocket gopher	M													4-7; 1-2 litters	
PELO	15	little pocket mouse	L														density 3-29/ha, avg. 14-15
MAFL	4	yellow-bellied marmot	M													4-8; avg. 4-6; 1 litter	
AMLE	15	antelope ground squirrel	L														density 1-4/ha
SPTO	15	Townsend ground squirrel	L													5-10; avg. 8-10; 1-2 litters	
SPRI	15	Richardson ground squirrel	L														
SPBE	15	Belding ground squirrel	L													6-7; 1 litter	
SYNU	5	mountain cottontail	L													4-8; avg. 6; 1-2 litters	
LETO	5	white-tailed jackrabbit	L													3-6; 2-3 litters	
LECA	5	black-tailed jackrabbit	M													1-6; avg. 2; 3-4 litters	
EUMI	15	least chipmunk	L													4-6; 1-2 litters	greasewood ♂ 453 m^2, ♀ 419 m^2; big sage ♂ 413 m^2, ♀ 433 m^2

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
16 ha (40 ac)/population	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	○■	●■	●■	●■	○□	●■	●■		+
					●■																		0
		●■	●■	○□		●■		●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	●■	□	□		●■	+
					●■		●■															●■	0
32 ha (80 ac)/population	●■			●■				●■								●■		●■		●■		○□	0
								●■														○□	0
16 ha (40 ac)/population		●■	●■	○□		●■		●■								●■	●■	●■		●■	○□	○□	0
≥41 ha (100 ac)/population					○□	●■	●■	●■	○□	●■	●■	●■	●■			●■	●■			●■		●■	0
≥65 ha (160 ac)/population	■	■	■	□				●■	■	■	■	■	■			■	■			■		●■	-
≥65 ha (160 ac)/population	■	■	■	■	■	●■	■	●■	■	■	■	■	■			■	■			■		●■	-
≥32 ha (80 ac)/population					○□	●■	●■	●■		●■	●■	○□	●■									○□	0

Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)

Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)

L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
EUAM	15	yellow pine chipmunk	L													5-7; 1 litter	
LACI	9	hoary bat[2]														2 young	
EUMAC	4	spotted bat	L													1 young	
PLTO	4	western big-eared bat	M													1 young	
ANPA	4	pallid bat	M													2 young	
SYID	5	pygmy rabbit	L													avg. 6; 1-2 litters	
MYCA	4	California myotis	M													1 young	
MYLE	4	small-footed myotis	L													1 young	
LANO	14	silver-haired bat[2]	L													2 young	
PIHE	4	western pipistrelle	L													2 young	
EPFU	4	big brown bat	M													1 young	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
≥32 ha (80 ac)/population								● ■				● ■										○ □	+
																						□	0
					● ■			○ □								● ■	● ■	● ■		● ■		● □	0
								● ■								● ■	● ■	● ■	○ □	● ■	○ □	● □	0
			□	□	□	□	□	● ■	□			● ■		□	□	● ■	● ■	● ■	○ □	● ■	○ □	● □	0
≥243 ha (600 ac)/population					● ■	● ■	● ■	● ■				● ■										● ■	0
			□	□			□	● ■				● ■		○ □	○ □	● ■	● ■	○ □	● ■	○ □		● □	0
								● ■								● ■	● ■	○ □	● ■	○ □		● □	0
					■	■	■	■	■	■	■	■	■			● ■	● ■	○ □	● ■	○ □		□	0
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Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
MYLU	4	little brown myotis	M													1 young	
MYYU	14	Yuma myotis	L													1 young	
MYEV	14	long-eared myotis	L													1 young	
MYTH	4	fringed myotis	L														
MYVO	14	long-legged myotis	L													1 young	
PLNI	5	snow bunting[2]														4-6	
		MAMMALS															
SOPR	16	Malheur shrew	L														
SOVA	16	wandering shrew	L													2-9; avg. 4-6; 1 litter	372 m^2 (4,000 ft^2)
SOME	15	Merriam shrew	L													5-7; 1 litter	
ZOAT	7	golden-crowned sparrow[2]														4-5	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
			□	□				● ■				● ■		○ □	○ □	● ■	● ■	○ □	● ■	○ □		● □	0
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					■	■	■	■	■	■	■	■	■			● ■	● ■	○ □	● ■	○ □		□	0
												● ■				● ■	● ■	○ □	● ■	○ □		□	0
					■	■	■	■	■	■	■	■	■			● ■	● ■	○ □	● ■	○ □		□	0
																						□	0
≥2 ha (5 ac)/population		● ■	● ■													● ■	● ■	○ □	● ■	○ □	○ □		-
≥2 ha (5 ac)/population		● ■	● ■					● ■								● ■	● ■	○ □	● ■	○ □	○ □		0
≥8.1 ha (20 ac)/population						● ■		● ■				● ■											0
																						□	0

Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PAIL	7	fox sparrow[2]														4-5	
MELI	6	Lincoln's sparrow[2]														4-5	
MEMEL	7	song sparrow	L													3-5	sage 20.5 ha/pr.; aspen 2.2 ha/pr.
CALA	5	Lapland longspur[2]														4-7	
JUHY	5	northern junco	M													4-5	juniper 2.4-13.5 ha/pr. (nesting)
SPARB	11	American tree sparrow[2]	L													4-5	
SPPA	7	chipping sparrow	M													3-5	juniper 1.4-2.3 ha/pr. (nesting); p. pine 1.9-2.5 ha/pr. (nesting)
SPBRE	7	Brewer's sparrow	L													3-4	sage 1.1-1.5 ha/pr.
ZOLE	7	white-crowned sparrow[2]														3-5	
AMSA	5	grasshopper sparrow	L													4-5	
POGRA	5	vesper sparrow	L													4-6	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
																						□	0
																						□	0
					■	● ■	■	● ■	■	■	■	● ■	■		■	● ■	● ■	● ■	■	○ □	○ □	○ □	0
																						□	0
			■	■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	□	○ □	○ □	○ □	0
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density – 25/100 ha						● ■	□	● ■	□	□	□	● ■	■	□	● ■	□	□	□	□	□	□	□	0
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Reproduction orientations

▨, ● Primary (>40%)

▨, ○ Secondary (<40%)

Feeding orientations

▒, ■ Primary (>40%)

▒, □ Secondary (<40%)

L – Low

M – Medium

H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CHGR	5	lark sparrow	M	3-5	
AMBl	7	black-throated sparrow			aspen 4.2 ha/pr.
AMBE	7	sage sparrow	L	3-4	sage 1.2-1.7 ha/pr. (nesting)
CATR	8	American goldfinch	M	3-6	aspen 3.9 ha/pr.
CAPS	7	lesser goldfinch	L	4-5	
PICH	7	green-tailed towhee	M	4	aspen 3.7 ha/pr.
PIER	7	rufous-sided towhee	M	3-6	aspen 7.5 ha (18.6 ac)/pr.
PASA	5	savannah sparrow	L	4-5	
CACAS	11	Cassin's finch[2]		4-5	juniper 6.7 ha/pr. (nesting); aspen 3.9 ha (9.8 ac)/pr.
CAMEXI	9	house finch	L	4-5	juniper 1.5-1.9 ha/pr. (nesting)
LEAT	4	black rosy finch[2]	L	3-5	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
	□		■	■		● ■		● ■	□	■	■	■	■	● ■	● ■	● □	● □	● □	● ■	○ □	○ □	□	0
						□		□	□					□									0
density – 50/100 ha (good)						● ■	□	● ■	□	□	□	● ■	● ■	□	● ■	□	□	□		□	□	□	0
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density 6/100 ha					□	□	□	■	■	■	■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	□	○ □	○ □	○ □	0
	□	■	□	□	□	□																	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)

L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CAFL	9	common redpoll[2]															
CAPI	11	pine siskin[2]														3-6	aspen 2.5 ha/pr.
PHME	11	black-headed grosbeak[2]														3-4	aspen 5.8 ha/pr.
PACY	8	indigo bunting[2]															
PAAMO	7	lazuli bunting	L													3-4	
HEVE	11	evening grosbeak[2]														3-4	
CAPU	11	purple finch	L													4-5	aspen 3.4 ha (9.3 ac)/pr.
ICGA	9	northern oriole	L													3-6	ranges from 2.7 ha to colonial with 17 prs./ha
EUCY	7	Brewer's blackbird	M													4-6	
MOAT	7	brown-headed cowbird	M													4-6	
PILU	10	western tanager	L													3-5	p. pine 10.1 ha/pr. (nesting)

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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																							0
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Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Letter code	Life form number	Species	Versatility rating	Activity/seasonal occurrence	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
				January February March April May June July August September October November December		
PHLU	9	rose-breasted grosbeak[2]				aspen 3.6 ha (8.9 ac)/pr.
PADO	14	house sparrow	L		5-6/clutch; 1-3 clutches	
DOOR	5	bobolink	L		4-7	
STNEG	5	western meadowlark	M		3-7	sage 20.5 ha/pr. (nesting)
XAXA	3	yellow-headed blackbird	L		3-5	
AGPH	7	red-winged blackbird	M		3-5	
GETR	3	common yellowthroat	L		3-5	
ICVI	8	yellow-breasted chat	L		3-5	
SEAU	7	ovenbird[2]				
WIPU	5	Wilson's warbler	L		3-6	
SERUT	9	American redstart[2]			3-5	aspen 3.3 ha/pr.

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
														□	□	□	□	□		□	□	□	0
			■	■	□	□	□	■	□	□	□	□	□	● ■	● ■	● ■	● ■	● ■	■	○ □	○ □	○	+
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0.4-2.0 ha (1-5 ac)alkali marsh/population			□	□				○ □								● ■	□	□	● ■	○ □		□	0
			● ■	● ■	■	■	■	● ■	■	■	■	■	■	● ■	● ■	● ■	● ■	● ■	● ■	○ □	○ □	□	0
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			□	□				□	□	□				● ■	● ■	● ■	● ■	● ■	■	○ □	○ □		0
														□	□	● ■	● ■	● ■		○ □	○ □	□	0

Reproduction orientations

▨, ● Primary (>40%)

////, ○ Secondary (<40%)

Feeding orientations

▒, ■ Primary (>40%)

▬, □ Secondary (<40%)

L – Low

M – Medium

H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
DEPE	8	yellow warbler	L				▒	▨	▨	▒	▒	▒				4-5	aspen 1.8 ha (4.4 ac)/pr.
DECOR	10	yellow-rumped warbler	L			▒	▨	▨	▨	▒	▒	▒	▒			3-5	p. pine 1.4-1.9 ha/pr. (nesting); aspen 2.6 ha (6.4 ac)/pr.
DENI	10	black-throated gray warbler	L				▨	▨	▨	▒	▒	▒				3-5	juniper 20.5 ha/pr. (nesting)
DETO	10	Townsend's warbler	L				▨	▨	▨	▒	▒	▒				3-5	
OPTO	7	MacGillivray's warbler					▨	▨	▨	▒	▒	▒				3-5	aspen 3.7 ha/pr.
STVU	14	European starling	L	▒	▒	▒	▨	▨	▨	▨	▨	▒	▒	▒	▒	4-6/clutch; 1-6 clutches	
VISO	11	solitary vireo[2]					▨	▨	▨	▨	▒	▒				3-5	
VIOL	11	red-eyed vireo	L					▨	▨	▨	▒	▒				3-4	aspen 1.4 ha (3.4 ac)/pr.
VIGI	11	warbling vireo	L				▨	▨	▨	▨	▒	▒				3-5	aspen 1.6 ha (3.9 ac)/pr.
VECE	6	orange-crowned warbler	L				▒	▨	▨	▒	▒	▒				4-6	
ANSP	5	water pipit[2]				▒	▒	▒	▨	▨	▨	▒	▒			4-7	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
BOGA	9	Bohemian waxwing[2]														4-6	
BOCE	9	cedar waxwing	L													3-6	
LAEX	7	northern shrike[2]														4-6	
LALU	7	loggerhead shrike	M													4-7	
SICU	14	mountain bluebird	M													4-6	juniper 1.8-2.3 ha/pr.
MYTO	6	Townsend's solitaire	M													3-5	juniper 8.1 ha/pr.
POCAE	7	blue-gray gnatcatcher	M														
RESA	10	golden-crowned kinglet[2]														5-9	
RECA	10	ruby-crowned kinglet	L													6-9	
IXNA	11	varied thrush[2]														3-5	
CAGN	5	hermit thrush[2]														3-5	p. pine 10-13.5 ha/pr.; aspen 3.4 ha/pr.

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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aspen 3.4 ha/pr to colonial	□	□	■	■	■	■	■	■	■	■	■	● ■	■	● ■	● ■	● ■	● ■	● ■	□	○ □	○ □	○ □	+
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Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CAUS	7	Swainson's thrush	L													3-5	
CAFU	5	veery	L													3-5	aspen 2.2 ha/pr.
SIME	14	western bluebird	M													4-6	
MIPO	7	northern mockingbird[2]														3-6	
DUCA	7	gray catbird	L													3-5	aspen 7.5 ha (18.6 ac)/pr.
TORU	7	brown thrasher	M														
ORMO	7	sage thrasher	L													4-5	sage 2.9-4.5 ha/pr.
TUMI	7	American robin	M													3-5	juniper 1.9-3.4 ha-pr.; aspen 2.3 ha (5.6 ac)/pr.
TRAE	14	house wren	L													5-8	aspen 1.9 ha/pr.
TRTR	3	winter wren[2]														5-7	
CIPA	3	marsh wren	L													3-7	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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aspen 3.4 ha/pr to colonial												●		●	●	●	●	●		○	○	○	+
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Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CAMEXO	4	canyon wren	M													4-6	
SAOB	4	rock wren	M													5-8	sage 40.5 ha/pr.
PSMI	8	bushtit	M													5-7	
SICAR	13	white-breasted nuthatch	L													5-9	p. pine 2.5-13.5 ha/pr.
SICAN	13	red-breasted nuthatch	L													4-7	p. pine 1.4-2.1 ha/pr.; aspen 7.5 ha-pr.
CEFA	14	brown creeper	L													4-8	p. pine 2.5-4.5 ha/pr.
CIME	3	dipper	L													3-6	
COBRA	11	American crow	M													4-6	
GYCY	10	pinyon jay	L													3-4	density 20.3 ha/pr. (nesting)
NUCO	10	Clark's nutcracker[2]														2-4	density 20.3 ha/pr. (nesting)
PAATR	14	black-capped chickadee	L													4-9	aspen 5.4 ha/pr.

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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Reproduction orientations
▨, ● Primary (>40%)
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PAGA	14	mountain chickadee[2]														7-9	juniper 1.8-3.1 ha/pr.; p. pine 1.0-1.9 ha/pr.
PECA	11	gray jay[2]														3-5	
CYST	11	Steller's jay	L													3-5	
APCO	7	scrub jay	M														
PIPI	7	black-billed magpie	M													6-9	
COCOR	4	northern raven	H													4-7	density ≤25 km²/pr.
IRBI	14	tree swallow	L													4-6	aspen 2.3 ha/pr. to colonial
RIRI	16	bank swallow	L													4-5	
STRU	16	rough-winged swallow	L													4-8	
HIRU	4	barn swallow	M													4-6	
PEPY	4	cliff swallow	M													4-6	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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≥25 km²/pair (≥6,400 ac)	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	■	○ □	○ □	● ■	+
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Reproduction orientations
▨, ● Primary (>40%)
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Feeding orientations
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L – Low
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
COSO	11	western wood pewee	L	3-4	≃ 20.3 ha/pr. – juniper; ≃ 2.5 ha (6.3 ac)/pr. – aspen
NUBO	10	olive-sided flycatcher[2]		3	
ERAL	5	horned lark	L	3-5	density: 2-5 prs./100 ha – openings; 10-40 prs./100 ha – sage
TATH	14	violet-green swallow	L	4-5	
SASA	4	Say's phoebe	M	4-5	
EMTR	7	willow flycatcher	M	3-4	
EMHA	11	Hammond's flycatcher[2]		3-4	
EMWR	7	gray flycatcher	M	3-4	
EMDI	10	western flycatcher	M	3-4	
PIPU	13	downy woodpecker	L	4-7	juniper, p. pine 4.0 ha/pr., aspen 7.5
PIAL	13	white-headed woodpecker	L	3-5	nesting terr. 8.1 ha (20.0 ac)/pr.

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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breeding density: ≃0.8 ha/pr –juniper; 1.3 ha/pr – p. pine; 2.5 ha/pr – aspen														●	●	●	●	●		○	○		0
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breeding density: ≃0.8 ha/pr –juniper; 1.3 ha/pr – p. pine; 2.5 ha/pr – aspen												●											0
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breeding density: ≃0.8 ha/pr –juniper; 1.3 ha/pr – p. pine; 2.5 ha/pr – aspen								●		●	●	●	●	●	●								0
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breeding density: ≃0.8 ha/pr –juniper; 1.3 ha/pr – p. pine; 2.5 ha/pr – aspen												●	●		●	●	●	●		○	○		0
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Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
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L – Low
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
TYTY	7	eastern kingbird	L													3-5	aspen 3.8 ha (9.3 ac)/pr.
TYVE	11	western kingbird	L													3-5	
MYCI	14	ash-throated flycatcher	M													3-5	
COAU	13	common flicker	M													5-10	juniper 4.5 ha/pr.; p. pine 16.2 ha/pr.; aspen 5.0 ha/pr.
PILE	13	Lewis' woodpecker	L													6-8	nesting terr. 6.1 ha (15.0 ac)/pr.
SPVAR	13	yellow-bellied sapsucker	L													4-6	juniper, p. pine 4.0 ha/pr., aspen 5.8 ha/pr.
SPTH	13	Williamson's sapsucker	L													3-7	nesting terr. 4.0 ha (10.0 ac)/pr. (≤20 ha/pr.
PIVI	13	hairy woodpecker	L													3-6	juniper, p. pine 10.1 ha/pr., aspen 7.5 ha/pr.
SEPL	7	broad-tailed hummingbird[2]														2	aspen 3.8 ha/pr.
SERUF	11	rufous hummingbird[2]														2	
STCAL	7	calliope hummingbird	L													2	

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	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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Reproduction orientations
, ● Primary (>40%)
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H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CAAN	7	Anna's hummingbird	L														
MEAL	16	belted kingfisher	L													5-8	
CHMI	6	common nighthawk	M													2/clutch; 1 clutch/yr	≃ 20.2 ha/pr. (50 ac)
CYNI	4	black swift	L													1	
CHVA	14	Vaux's swift	L													3-5	
AESA	4	white-throated swift	L													3-6	
ARAL	7	black-chinned hummingbird[2]														2	
ATCU	15	burrowing owl	L													5-9	loosely colonial
ASOT	11	long-eared owl	L													3-8	
ASFL	5	short-eared owl	L													4-9	
AEAC	14	saw-whet owl	L													4-7	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
			■	■								● ■	● ■	● ■	● ■	● ■	● ■	● ■	□	○ □	○ □	□	0
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Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PHNU	6	poorwill	L													2	
TYAL	14	barn owl	L													5-7	h.r. ≥202 ha (500 ac)/pair
OTAS	14	common screech owl	L													4-5	
OTFL	14	flammulated owl														2-4	nesting terr. 6.1-12.1 ha (15-30 ac)
BUVIR	12	great horned owl	M													2-3	h.r. 1,214 ha (3,000 ac)
GLGN	14	pygmy owl	L													3-4	
STCAS	3	Caspian tern	L													2-3	
CHNI	3	black tern	L													3	
COLI	4	rock dove	L													2	
ZEMA	11	mourning dove	M													2/clutch; 1 clutch	density 7-10 prs./40.5 ha (juniper)
COAM	8	yellow-billed cuckoo	L													2-4	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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Reproduction orientations
, ● Primary (>40%)
, ○ Secondary (<40%)
Feeding orientations
, ■ Primary (>40%)
, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
LACA	3	California gull	L													2-3	
LADE	3	ring-billed gull[2]														2-4	
LAPI	3	Franklin's gull	L													3	
LAPH	3	Bonaparte's gull[2]														2-4	
STFO	3	Forster's tern	L													3-4	
REAM	3	American avocet	L													3-4	
HIME	3	black-necked stilt	L														
STTRI	3	Wilson's phalarope	L													4	
LOLO	3	northern phalarope[2]														4	
LAAR	3	herring gull[2]														2-3	
CABA	3	Baird's sandpiper[2]														4	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
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															● ■	□	● ■	● ■	○ □	□	● ■	0
																					□	0
																					□	0
																					□	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CAMI	3	least sandpiper[2]														4	
CAMAU	3	western sandpiper[2]														4	
LISC	3	long-billed dowitcher[2]														4	
LIFE	3	marbled godwit[2]															
TRSO	7	solitary sandpiper[2]														4	
TRME	3	greater yellowlegs														4	
TRFL	3	lesser yellowlegs[2]														4	
CASE	3	willet[2]														3-4	
CAMEL	3	pectoral sandpiper[2]														4	
CHVO	3	killdeer	L													4	
CHMO	3	mountain plover[2]														3	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
																					□	0
																					□	0
																					□	0
																					□	0
uses blackbird nests																					□ ○	0
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			● ■	● ■											● ■	● ■	● ■	□	○ □	○ □	○ □	0
																					● ■	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
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L – Low
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CAGA	3	common snipe	L													4	
NUAM	5	long-billed curlew	M													4	
ACMA	3	spotted sandpiper	L													4	
RALI	3	Virginia rail	L													5-12	
POCAR	3	sora	L													6-15	
FUAM	3	American coot	L													8-12	
CHSEM	3	semi-palmated plover[2]															
CHALE	3	snowy plover														2-3	
ORPI	5	mountain quail	L													5-15	≃ breeding density of 1 bird/3 ac (near water)
ALCH	4	chukar	L													8-15	density 20 ac/bird
PEPER	5	gray partridge	L													10-22	h.r. covey 1/8-1/4 mi; density 10-30 ac/bird (nesting)

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
			● ■	● ■												● ■	○ □	○ □	● ■	○ □	○ □	□	0
≥ 2 ha (5 ac) traditional sites/pair	□		■	■	● ■	● ■	□	● ■								● ■	● ■	● ■	○ □	○ □	○ □	□	0
			□	□												● ■	● ■	● ■	□	○ □	○ □	○ □	0
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water critical, each water point has effective area of 2,000 ac					■	● ■	■	● ■	● ■	■	■	□	■	□	□	■	■				□	● ■	0
	□		■	■		● ■	□	● ■	□	□	□	□	□			● ■	● ■	● ■		○ □	○ □	□	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
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Letter code	Life form number	Species	Versatility rating	Activity/seasonal occurrence (January, February, March, April, May, June, July, August, September, October, November, December)	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PHCOL	5	ring-necked pheasant	L		6-14	
GRCA	3	sandhill crane			2	
FASP	14	American kestrel	M		3-5	
DEOB	5	blue grouse	L		5-10	1.5-5.0 ac/male/ nesting territory
BOUM	5	ruffed grouse	L		8-14	aspen 8.3 ha/pr.; brood range ≤ 125 ac
CEUR	5	sage grouse	M		7-13; avg. 7.13 in Oregon	1 lek/5.7 mi^2; ≤12.5 ♂'s/mi^2, 30-50/mi^2
LOCA	5	California quail	L		10-17	≃ breeding density of 1 bird/2 ac (occupied area)
CICY	5	northern harrier	L		4-6	
PAHA	12	osprey			2-4	
FAME	4	prairie falcon	M		3-6	
FAPE	4	peregrine[2]			2-4	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
			□	□		□		● ■	□		□	□	□	□		● ■	● ■	● ■		○ □	○ □	○ □	0
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density ≤ ♂/8-94 ac									■	■	■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	□	○ □	○ □	○ □	0
one protected lek/population, density 10/640 ac					■	● ■	■	● ■	□	□	□	■	■		■	■	■	■		□	□	□	0
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0.4 km (0.25 mi) undisturbed cliff/pair	● ■	□	■	■	■	● ■	● ■	■	□	□	□	■	□	□	■	■	■	■		□	□	● ■	0
0.8 km (0.5 mi) undisturbed cliff/pair																						● ■	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
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▒, □ Secondary (<40%)

L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
FACO	11	merlin[2]														3-6; avg. 4-5	
BUSW	7	Swainson's hawk	M													2-4	
BULA	4	rough-legged hawk[2]														2-6	
BUREG	4	ferruginous hawk	M													3-8	
AQCH	12	golden eagle	M													1-3	
HALE	12	bald eagle[2]														2-3	
CAAU	4	turkey vulture	M													1-3	
ACGE	11	northern goshawk														3-5	nesting terr. 5.8 km (3.6 mi) radius
ACST	11	sharp-shinned hawk	L													3-5	
ACCO	11	Cooper's hawk	L													3-5	
BUJA	12	red-tailed hawk	M													2-4	nesting terr. 1.3-7.8 km^2 (0.5-3.0 mi^2)

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
														● ■	● ■	● ■	● ■	● ■	● ■	●	●	○ □	0
nesting home range 1 pair per 6.7 km^2			□	□	□	■	■	● ■	□	■	■	● ■	■	● ■	● ■	● ■	● ■	● ■		○ □	○ □	□	+
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12.1 ha core nesting area within a 10,118 to 15,379 ha nesting terr. (30 ac/25,000-38,000 ac)/pair														● ■	■	● ■	● ■	● ■		○ □	○ □	□	0
12.1 ha core nesting area within a 10,118 to 15,379 ha nesting terr. (30 ac/25,000-38,000 ac)/pair			□	□				□	□	□	□	■	□	● ■	● ■	● ■	● ■				○ □	□	0
12.1 ha core nesting area within a 10,118 to 15,379 ha nesting terr. (30 ac/25,000-38,000 ac)/pair			□	□				○ □	■	■	■	■	■	● ■	● ■	● ■	● ■				○ □	□	0
	□	□	■	■	■	■	■	● ■	■	■	■	● ■	● ■	● ■	● ■	● ■	● ■	● ■		○ □	○ □	○ □	+

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
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L – Low
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Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
CLHY	3	oldsquaw[2]		■	■									■	■		
OXJA	3	ruddy duck	L	▒	▒	▒	▒	▒	▒	▨	▨	▒	▒	▒	▒	6-10	
LOCU	14	hooded merganser[2]		▒	▒	▒	▨	▨	▨	▒	▒	▒	▒	▒	▒	6-12	
MEMER	14	common merganser	L	▒	▒	▒	▨	▨	▨	▨	▨	▒	▒	▒	▒	6-12	
MESE	3	red-breasted merganser[2]		▒	▒	▒								▒	▒	8-10	
AYAF	3	lesser scaup	L	▒	▒	▒	▒	▨	▨	▨	▒	▒	▒	▒	▒	9-12	
BUCL	3	common goldeneye[2]		▒	▒	▒	▒	▒						▒	▒	5-19; avg. 8-12	
BUIS	14	Barrow's goldeneye		▒	▒	▒	▒	▨	▨	▨	▒	▒	▒	▒	▒	6-15; avg. 10	
BUALBE	14	bufflehead[2]		▒	▒	▒	▒	▒	▨	▨	▒	▒	▒	▒	▒	6-14; avg. 10-12	
SOSP	3	King eider[2]		■	■									■	■		
AISP	14	wood duck			▒	▒	▨	▨	▨	▒	▒	▒	▒	▒		10-15	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
																						□	0
																● ■		● ■		● ■		□	0
																						□	0
																● ■	● ■			□	● ■	○ □	0
																						□	0
																● ■		● ■	● ■			□	0
																						□	0
																● ■	● ■	● ■	■	■	■	□	0
																						□	0
																						□	0
≥0.8 ha (2 ac) of suitable marsh/pair																● ■	□	□	● ■	● ■	□	□	0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
AYAM	3	redhead														10-15	
AYCO	3	ring-necked duck	L													6-12	
AYVA	3	canvasback														7-9	
AYMA	3	greater scaup[2]														7-10	
ANCR	3	green-winged teal	L													10-12	
ANDIS	3	blue-winged teal	L													6-12	
ANCY	3	cinnamon teal	L													6-12	
ANAMEO	3	American wigeon	L													6-12	
ANCL	3	northern shoveler	L													6-14	
CHCA	3	snow goose[2]														4-12; avg. 5-7	
CHRO	3	Ross' goose[2]														3-9; avg. 5-7	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
0.2 ha (0.5 ac) emergent, riparian cover/pair																●		●		●			0
																■	□	■		■		□	
0.2 ha (0.5 ac) emergent, riparian cover/pair																●		●	●				0
			■	□												■	□	■	■	■	□	□	
																●		●		●			0
																■	□	■		■		□	
																							0
																						□	
0.2 ha (0.5 ac) emergent, riparian cover/pair					○		○	○								●		●					0
			■	□	□		□	□								■	■	■	□	■	□	□	
0.2 ha (0.5 ac) emergent, riparian cover/pair					○		○	○								●		●					0
			■	□	□		□	□								■	■	■	□	■	□	□	
0.2 ha (0.5 ac) emergent, riparian cover/pair					○		○	○								●		●					0
			■	□	□		□	□								■	□	■	□	■	□	□	
0.2 ha (0.5 ac) emergent, riparian cover/pair					○		○	○								●		●	●				0
			■	□	□		□	□								■	□	■	■	■	□	□	
0.2 ha (0.5 ac) emergent, riparian cover/pair					○		○	○								●		●	●				0
			■	□	□		□	□								■	□	■	■	■	□	□	
																							0
																						□	
																							0
																						□	

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
ANPL	3	mallard	L													8-10	
ANSTR	3	gadwall	L													7-13	
ANAC	3	common pintail	L													6-12	
IXEX	3	least bittern	L													4-7; avg. 4-5	
PLCH	7	white-faced ibis[2]														3-5	
OLCO	3	whistling swan[2]														2-7; avg. 4-5	
BRCA	3	Canada goose														4-10; avg. 5-6	
ANAL	3	white-fronted goose[2]														4-7; avg. 5-6	
BUST	7	green heron														3-6; avg. 4-5	
CAAL	12	common egret	L													3-5	colonial nester
BUIB	7	cattle egret	L														colonial nester

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
0.2 ha (0.5 ac) emergent, riparian cover/pair			■	□	○ □		○ □	○ □								● ■	● ■	● ■	● ■	● ■	□	○ □	0
0.2 ha (0.5 ac) emergent, riparian cover/pair			■	□	○ □		○ □	○ □								● ■	● ■	● ■	● ■	● ■	□	□	0
0.2 ha (0.5 ac) emergent, riparian cover/pair			■	□	○ □		○ □	○ □								● ■	● ■	● ■	● ■	● ■	□	□	0
			□													● ■	□	● ■	■	□		□	0
																□	□	□	□	□		□	0
																■	□	■	□	■		□	0
																● ■	○ □	● ■		● ■		□ □	0
																						□	0
																● ■	● ■	● ■		● ■		□	0
0.4 to 4.0 ha (1-10 ac)/colony	□		■	■				○ □				●		●	●	● ■	● ■	● ■	■	■		□	0
	□		■	■				○ □						● ■	● ■	● ■	● ■	● ■	■	■		□	0

Reproduction orientations

▨, ● Primary (>40%)

////, ○ Secondary (<40%)

Feeding orientations L – Low

▒, ■ Primary (>40%) M – Medium

■, □ Secondary (<40%) H – High

Letter code	Life form number	Species	Versatility rating	Activity/seasonal occurrence: January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
NYNY	7	black-crowned night heron	L				▨	▨	▨	▨	▨	▒	▒			3-6	colonial nester
BOLE	3	American bittern	L	▒	▒	▒	▒	▨	▨	▨	▨	▒	▒	▒	▒	3-7	
AEOC	3	western grebe	L	▒	▒	▒	▒	▨	▨	▨		▒	▒	▒	▒	3-10; avg. 5-7	nesting in dense colonies or singly
POPO	3	pied-billed grebe	L	▒	▒	▒	▨	▨	▨	▨	▨	▒	▒	▒	▒	3-10; avg. 5-7	1 pothole/pr
PEERY	3	American white pelican[2]									▒	▒	▒	▒		1-3; avg. 2	colonies of ≤50 nests
PHAU	3	double-crested cormorant		▒	▒	▒	▨	▨	▨	▒	▒	▒	▒	▒	▒	3-7; avg. 3-4	colonial nester
ARHE	12	great blue heron	L	▒	▒	▒	▨	▨	▨	▨	▒	▒	▒	▒	▒	3-6	colonial nester

BIRDS

GAIM	3	common loon[2]		▒	▒	▒	▒	▒					▒	▒	▒	1-3; avg. 2	≥ one 5-ha (12-ac) lake/pr.
POGRI	3	red-necked grebe[2]											▒	▒	▒	3-8; avg. 5-6	
POAU	3	horned grebe[2]					▨	▨	▨	▒	▒	▒	▒	▒		3-10; avg. 4-5	density 1.5-3.3 prs/km^2

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
0.4 to 4.0 ha (1-10 ac)/colony			■	■				○ □						● ■	● ■	● ■	● ■	● ■	■	■		□	0
			□													● ■	□	● ■	■	□		□	0
																● ■	● ■	● ■	● ■	● ■	□		0
one small pond with rush and/or tule emergents																● ■	□	● ■	● ■	● ■	□		0
requires protected island colonies						●		●								■	□	■	□	■	□		0
requires protected island colonies						●		●								○ ■	■	■	■	● ■	□	●	0
0.4 to 4.0 ha (1-10 ac)/colony	□		■	■				○ □				●		●	●	● ■	● ■	● ■	● ■	■	■	□	0
≥ one 4-ha (10-ac) lake/pair																■	■	■		■			0
																■	■	■		■			0
																● ■	■	● ■	● ■	● ■	□		0

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PONIGR	3	eared grebe	L													3-9; avg. 4-5	
THEL	3	wandering garter snake	M													10-20/litter; 1 litter	
SOSE	15	western ground snake	L													4-5/clutch; 1 clutch	
HYTO	5	night snake	L													2-6/clutch; 1 clutch	
CRVI	5	western rattlesnake	M													5-6/clutch; 1 clutch/2 yrs	h.r. ≤457 ha (1,130 ac)/individual
CHBO	5	rubber boa	L													2-8/litter; 1 litter	
COCONS	5	yellow-bellied racer	L													5-26; avg. 12/ clutch; 1 clutch	
MATA	5	striped whipsnake	L													3-5/clutch; 1 clutch	density .15-.22/ha
PIME	5	gopher snake	L													3-12/clutch; 1 clutch	
THST	3	common garter snake	H													10-20/litter; 1 litter	h.r. ♂ .51 ha (1.27 ac), ♀ .26 ha (.65 ac)
UTST	5	side-blotcher lizard	M													2-8; avg. 3-5/ clutch; 1-2 clutches	h.r. 121-446 m^2 (1,302-4,799 ft^2)/ adult [4-13 ha]

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)															Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
																● ■	■	● ■	● ■	● ■	□		0
≥10.1 ha (25 ac)/population			● ■	● ■			● ■	● ■	● ■			● ■		■	■	● ■	● ■	● ■	● ■	● ■		○ □	-
					● ■	● ■	● ■	● ■														● ■	-
≥20.2 ha (50 ac)/population					● ■	● ■		● ■				● ■										○ □	0
≥16.2 ha (40 ac)/population	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■			● ■	● ■	● □				● ■	0
						○ □		○ □		○ □	○ □	○ □	○ □	● ■		● ■	● ■	● ■				○ □	0
>20.2 ha (50 ac)/population communal hibernacula					○ □	● ■	● ■	● ■	○ □							● ■	● ■	● ■				● ■	0
>20.2 ha (50 ac)/population								● ■														○ □	0
≥20.2 ha (50 ac)/population			● ■	○ □	○ □	○ □	● ■	● ■	○ □	○ □	○ □	● ■	○ □	○ □	○ □							○ □	0
≥10.1 ha (25 ac)/population		● ■	● ■	● ■	● ■	● ■	● ■	● ■		● ■	● ■	● ■	● ■	■	■	● ■	● ■	● ■	● ■	● ■		○ □	-
>2.0 ha (5 ac)/population density 75-175/ha					● ■	● ■	● ■	● ■				● ■										○ □	-

Reproduction orientations
▨, ● Primary (>40%)
▨, ○ Secondary (<40%)
Feeding orientations
▒, ■ Primary (>40%)
▒, □ Secondary (<40%)
L – Low
M – Medium
H – High

Activity/seasonal occurrence

Letter code	Life form number	Species	Versatility rating	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
PHPL	5	desert horned lizard	L	3-9; avg. 6-8/ litter; 1 litter	general in broad areas
PHDO	5	short-horned lizard	L	16.7/litter; 1 litter	
EUSK	5	western skink	L		
CNTI	5	western whiptail	L	1-5; avg. 2-9/ clutch; 1 clutch	h.r. ♂ .07 ha, ♀ .07 ha; density = 4.0-16.0/ha
		REPTILES			
CRCO	4	collared lizard	L	3-12; avg. 5-7/ clutch; 1-2 clutches	♂'s very territorial
CRWI	5	leopard lizard	L	2-11; avg. 5.2/ clutch; 1 clutch	45-196 m (h.r.) (10/ha)
SCOC	4	western fence lizard	L	4-19; avg. 8-13/ clutch; 1-3 clutches	
SCGR	5	sagebrush lizard	M	avg. 5/clutch; 1 clutch	h.r. ♂ 25 m (82 ft), = ♀ 18 m (59 ft)
BUWO	2	Woodhouse toad	L	approx. 100 eggs/♀	h.r. 21.8-32.3 m^2 (234.6-347.5 ft^2)/ adult
HYRE	2	Pacific treefrog	M	100 + eggs/♀	

Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats						
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
≥12.1 ha (30 ac)/population density 1-7/ha	○ □				● ■	● ■	● ■	● ■	● ■	○ □	○ □	○ □	○ □									○ □	0
>8.1 ha (20 ac)/population	○ □				○ □	● ■	○ □	● ■	○ □	○ □	○ □	● ■	○ □									○ □	0
							● ■	○ □	○ □			● ■	● ■			□	□	□				○ □	0
>8.1 ha (20 ac)/population					● ■	● ■	● ■	● ■	○ □	○ □	○ □	● ■	● ■									○ □	0
≥2.0 ha (5 ac)/population	○ □				● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■	● ■									● ■	-
					● ■	● ■	● ■	● ■	○ □	○ □	○ □	○ □	○ □									● ■	-
>2.0 ha (5 ac)/population	○ □				○ □	○ □	○ □	● ■	● ■	● ■	● ■	● ■	● ■	○ □	○ □							○ □	+
>4.0 ha (10 ac)/population density 208/ha						○ □	● ■	● ■	● ■	● ■	○ □	● ■	○ □									○ □	0
	■		■	■				□						■	■	● ■		● ■	● ■	● ■		● ■	0
one 0.8-ha (2-ac) pond/ population			● ■	■	○ □	○ □	○ □	● ■		○ □	○ □	○ □	○ □	■	■	● ■	○ ■	● ■	● ■	● ■		● ■	-

Reproduction orientations

▨, ● Primary (>40%)

▨, ○ Secondary (<40%)

Feeding orientations

▒, ■ Primary (>40%)

■, □ Secondary (<40%)

L – Low

M – Medium

H – High

Letter code	Life form number	Species	Versatility rating	January	February	March	April	May	June	July	August	September	October	November	December	Reproduction capacity, potential/year	Home range (h.r.)/territory (t.) size
				Activity/seasonal occurrence													
RAPR	1	spotted frog	L														
RAPI	2	leopard frog	L														
RACA	1	bullfrog	L														

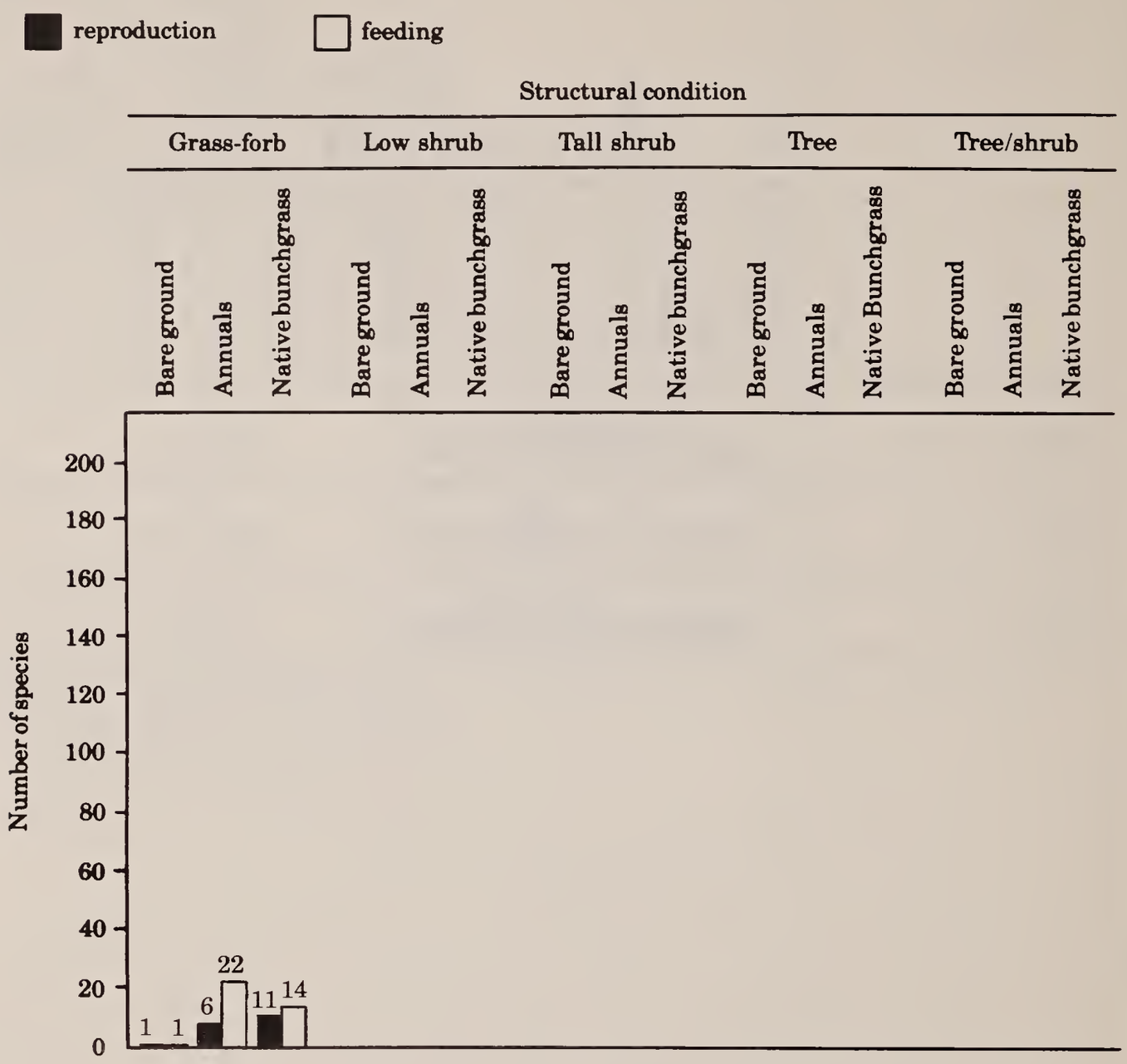
[1]Positive (+), negative (-), or neutral (0) net habitat associations (see chapter 13, Manmade Habitats, for fuller descriptions).

[2]Occurs in migration or accidentally only; see appendix 5.

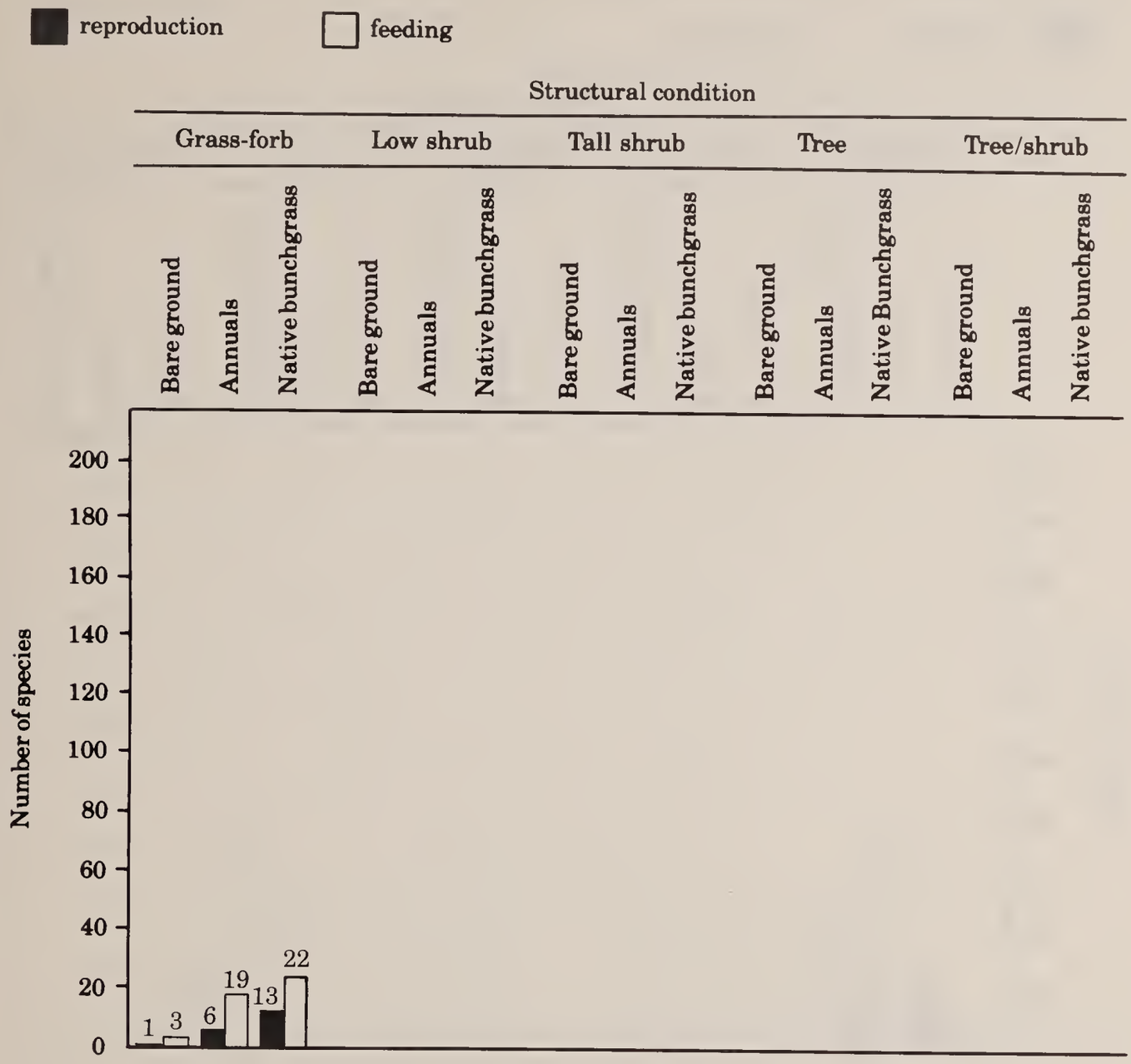
Minimum habitat required/ pair or population ac – acres ha – hectares	Plant community groups (habitat)																Special habitats							
	crested wheatgrass (seeded)	subalpine bunchgrass	perm. wet meadows	seasonally wet meadows	shadscale saltbush/bunchgrass	low sagebrush/bunchgrass	black greasewood/grass	tall sagebrush/bunchgrass	squaw apple/bunchgrass	curlleaf mountain mahogany/bunchgr.	curlleaf mountainmahognay/pinegr.	juniper/sagebrush/bunchgrass	curlleaf mountainmahogany/shrub	quaking aspen/grass	quaking aspen/mountain big sagebrush/ bunchgrass	riparian	River, creek, stream	Lake, reservoir, ponds	Marsh, bog, swamp	Standing, slow-moving water	Fast, running water	Geomorphic and/or edaphic	Manmade habitats[1]
one 0.8-ha (2-ac) pond/ population																● ■	□	● ■	● ■	● ■		■	0
one 0.8-ha (2-ac) pond/ population			□				□	□						□	□	● ■		● ■	● ■	● ■			0
one 1.6-ha (4-ac) pond/ population								○ □								● ■	○ □	● ■	□	● ■			0

Appendix 9. Summary of wildlife species' use of plant communities by structural conditions.

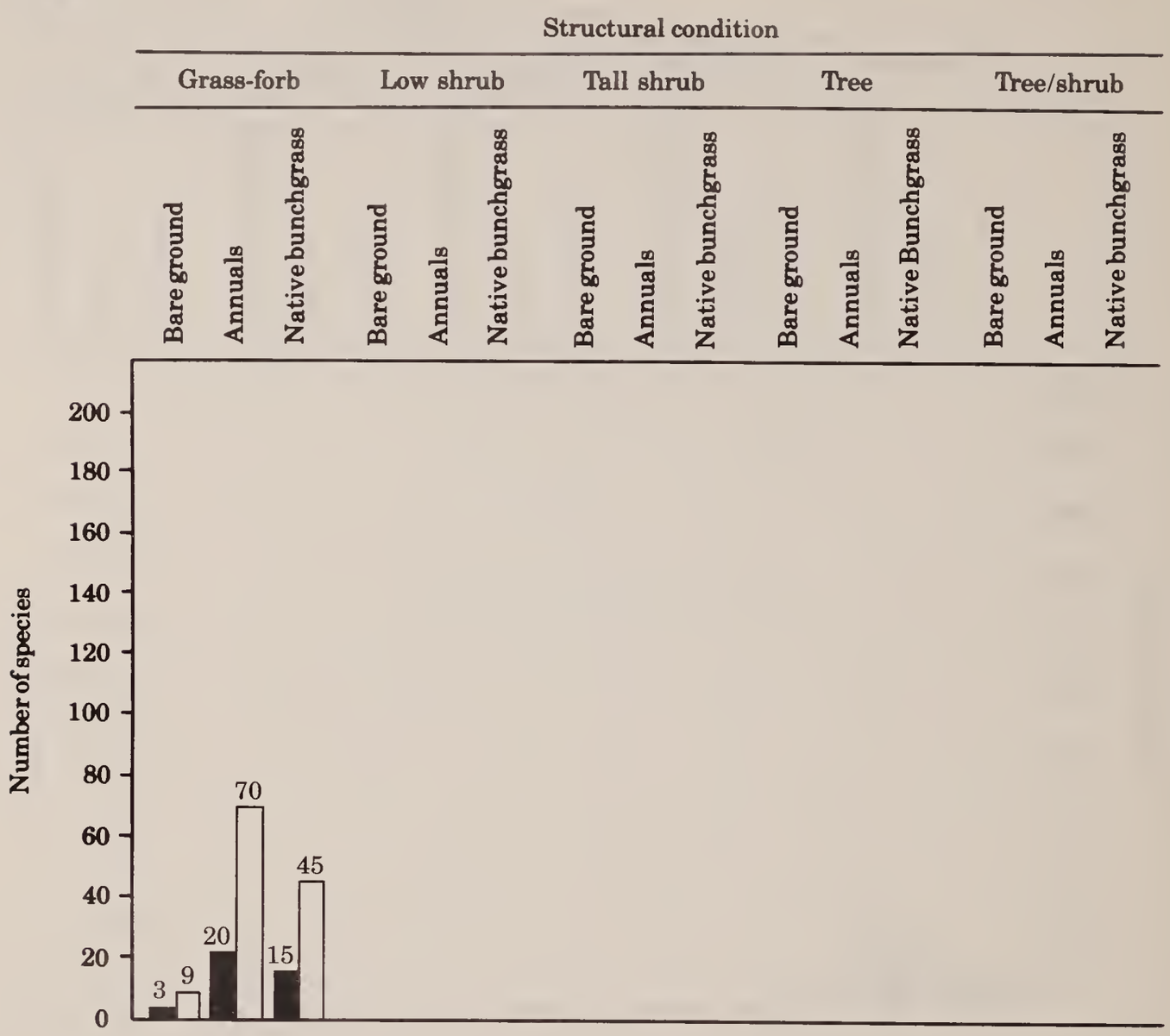
Plant community: Crested wheatgrass (seeded)



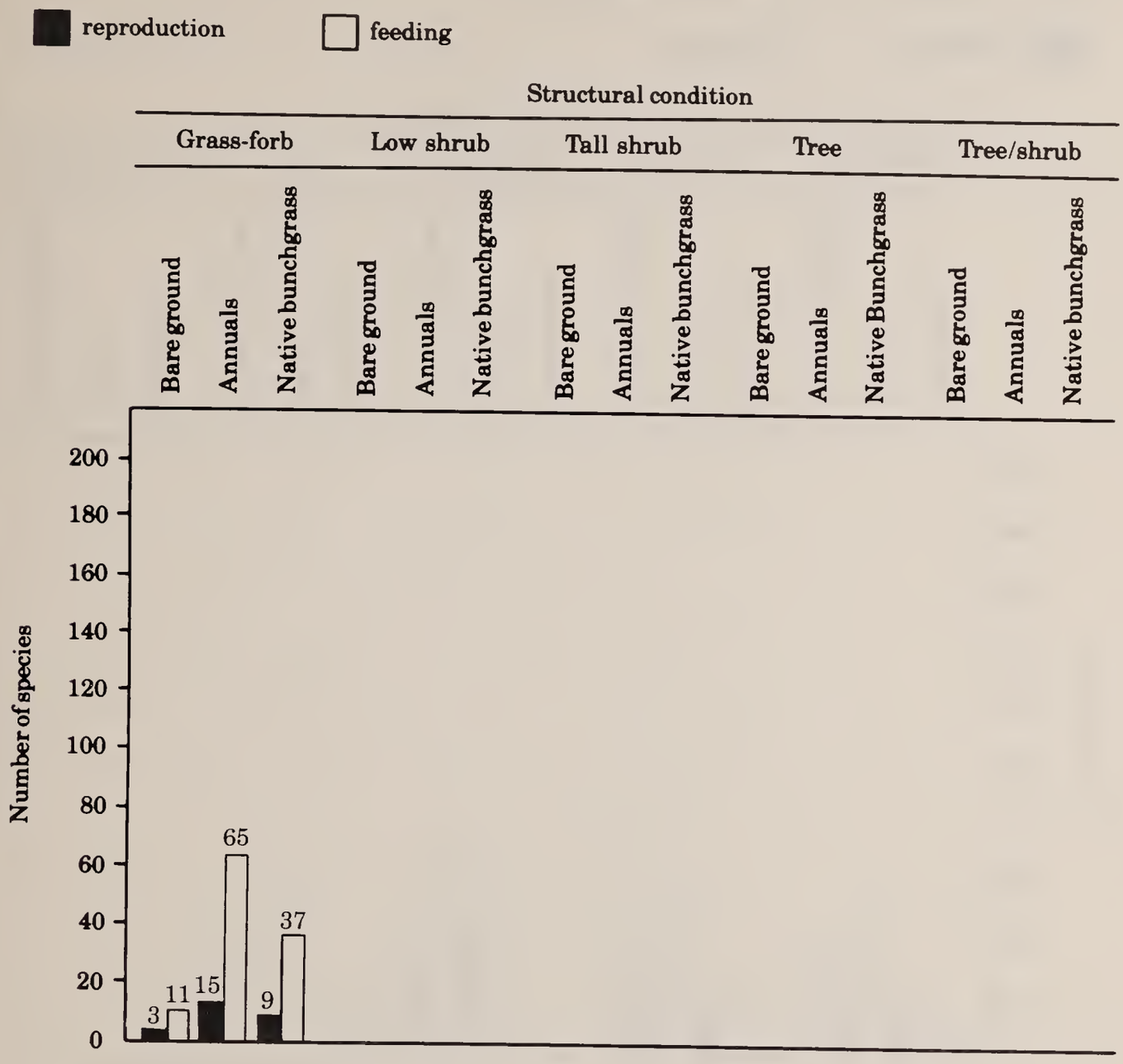
Plant community: Subalpine bunchgrass



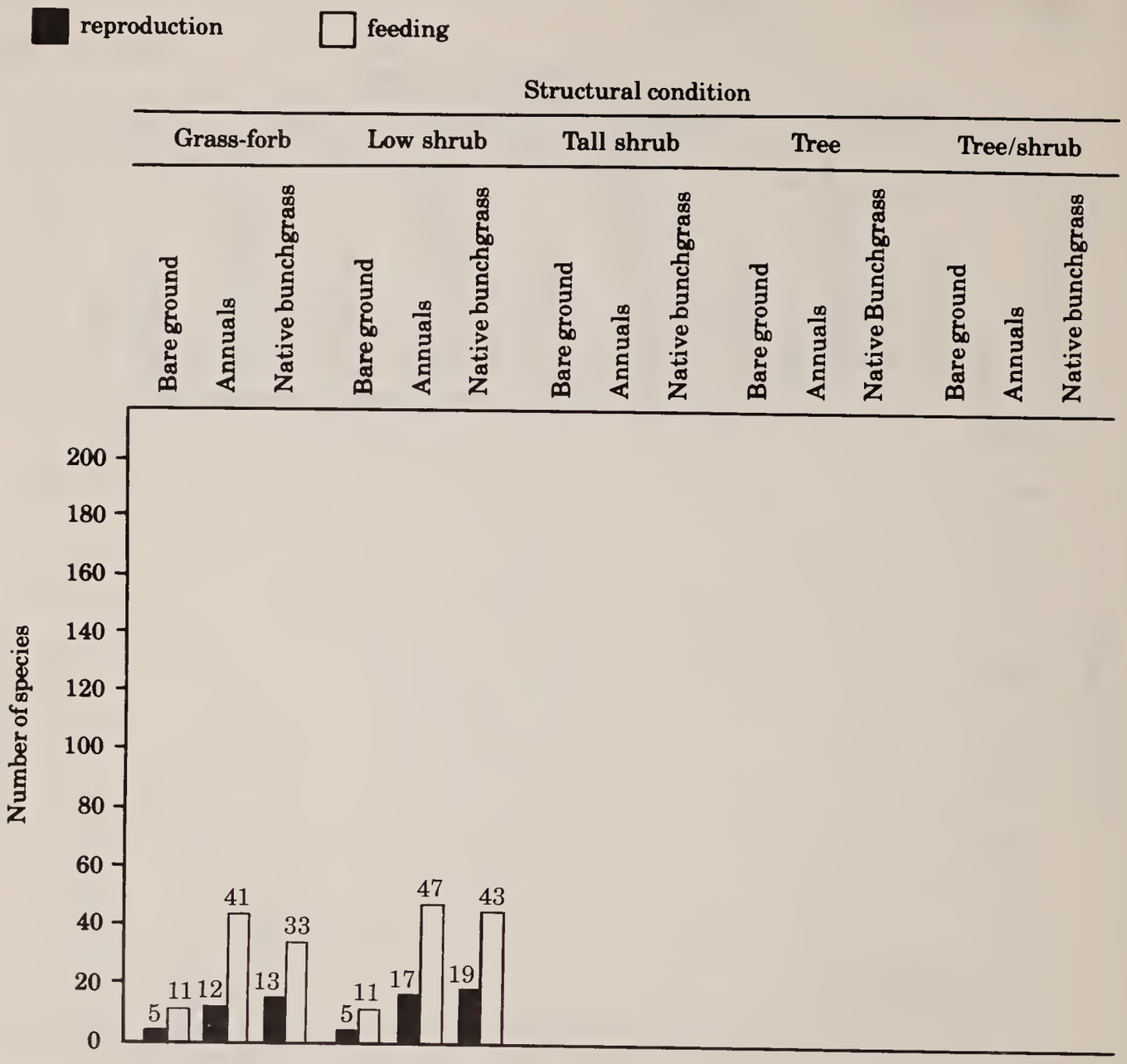
Plant community: Permanently wet meadows



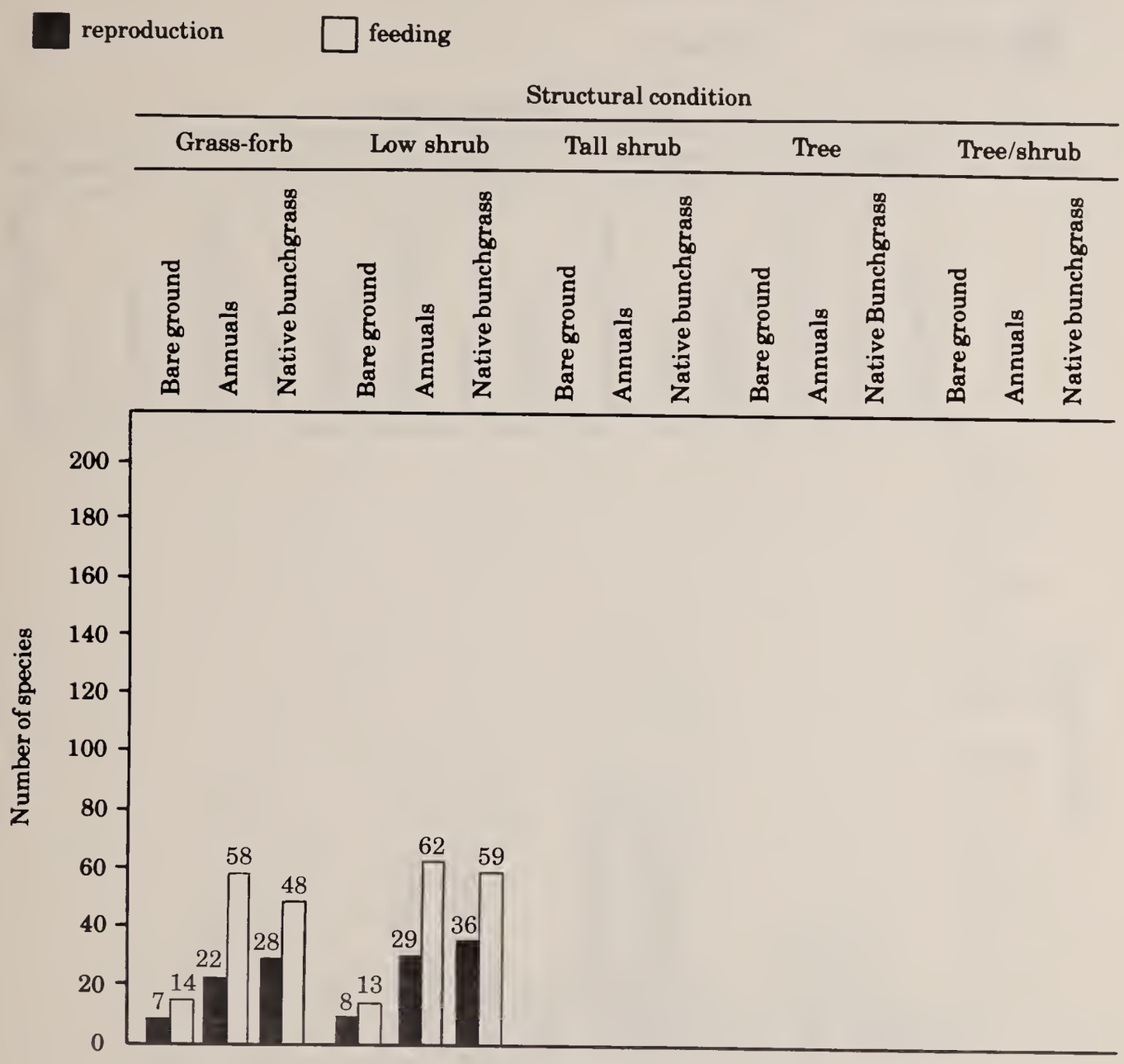
Plant community: Seasonally wet meadows



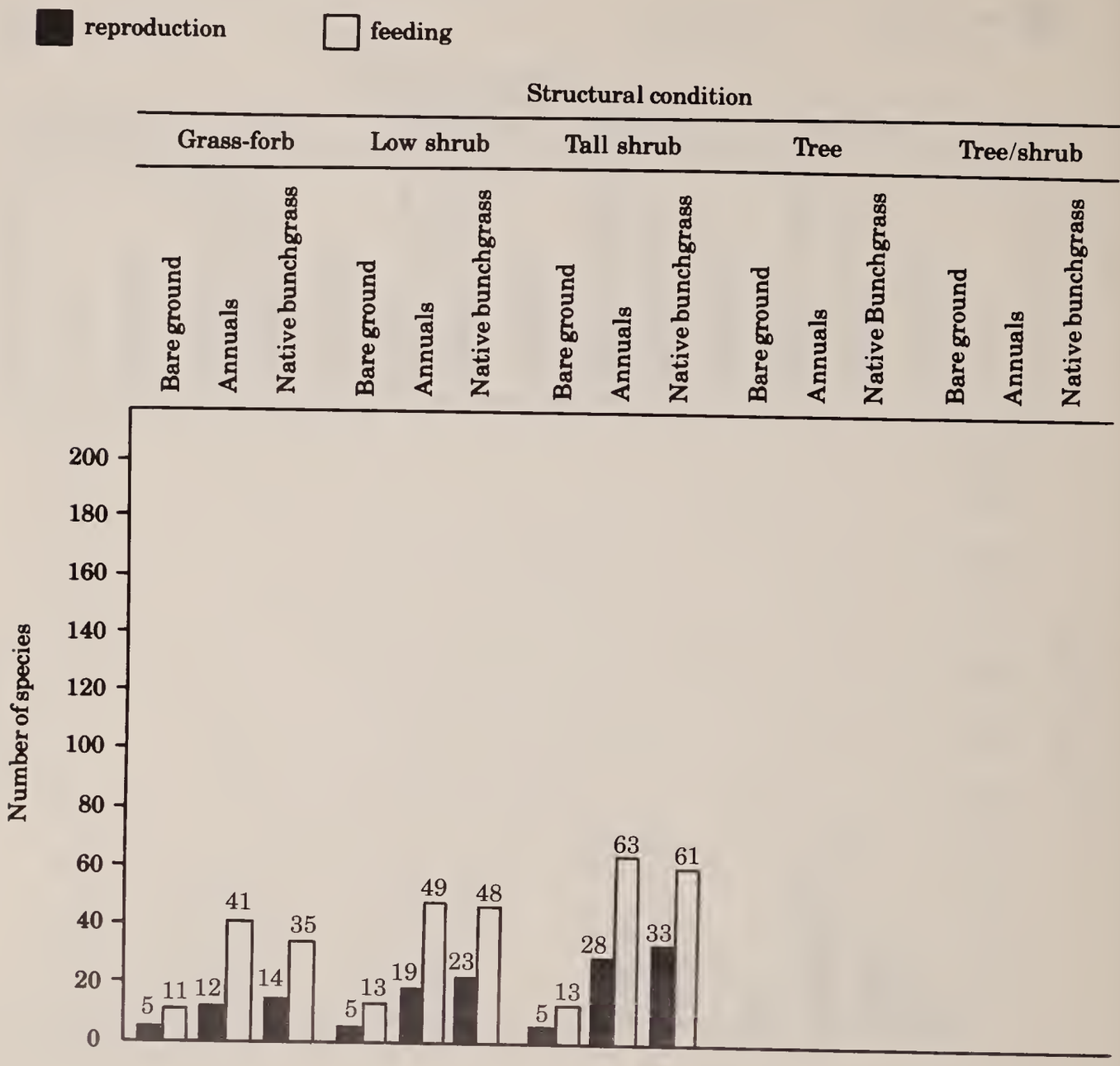
Plant community: Shadscale saltbush/bunchgrass



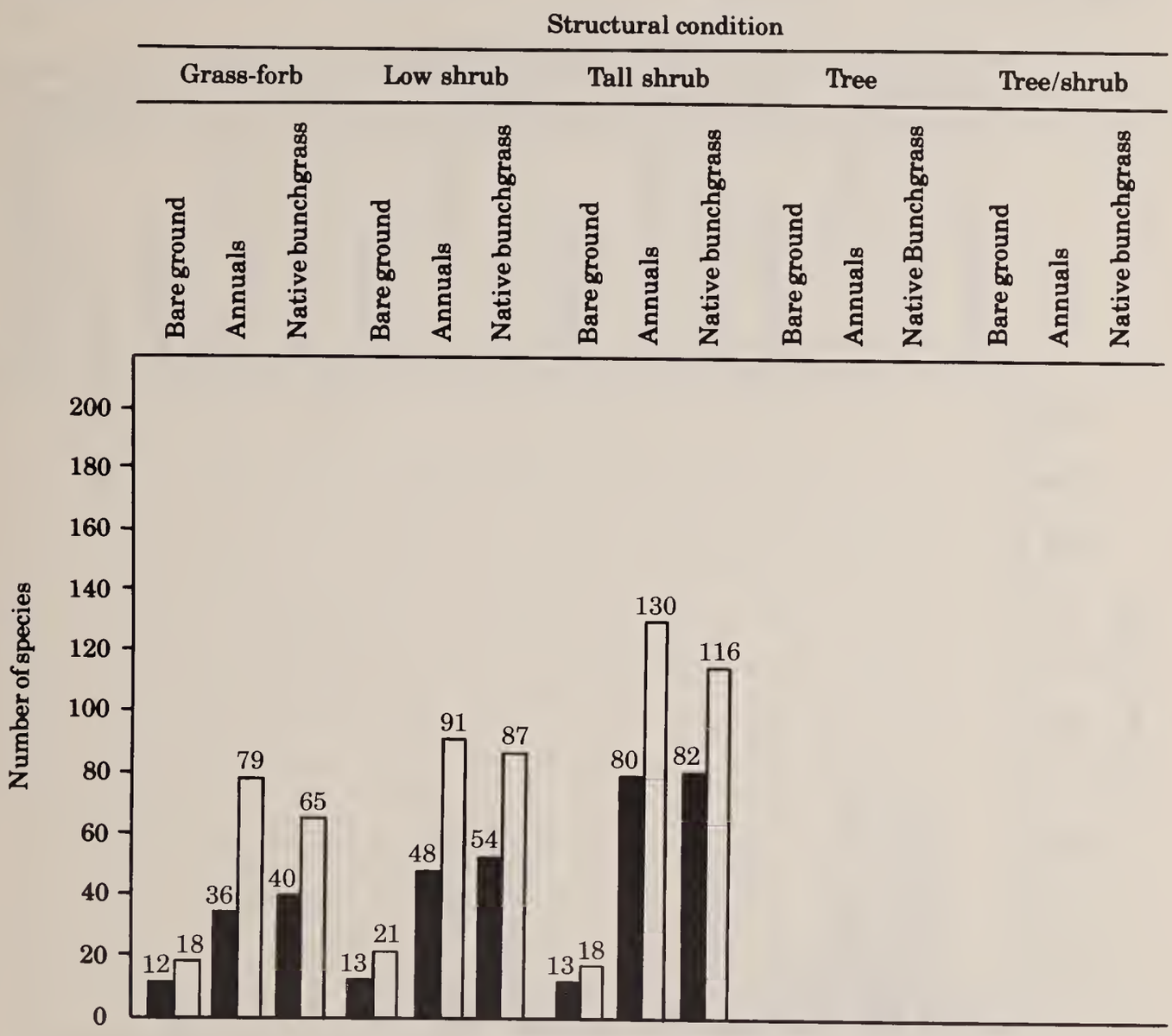
Plant community: Low sagebrush/bunchgrass



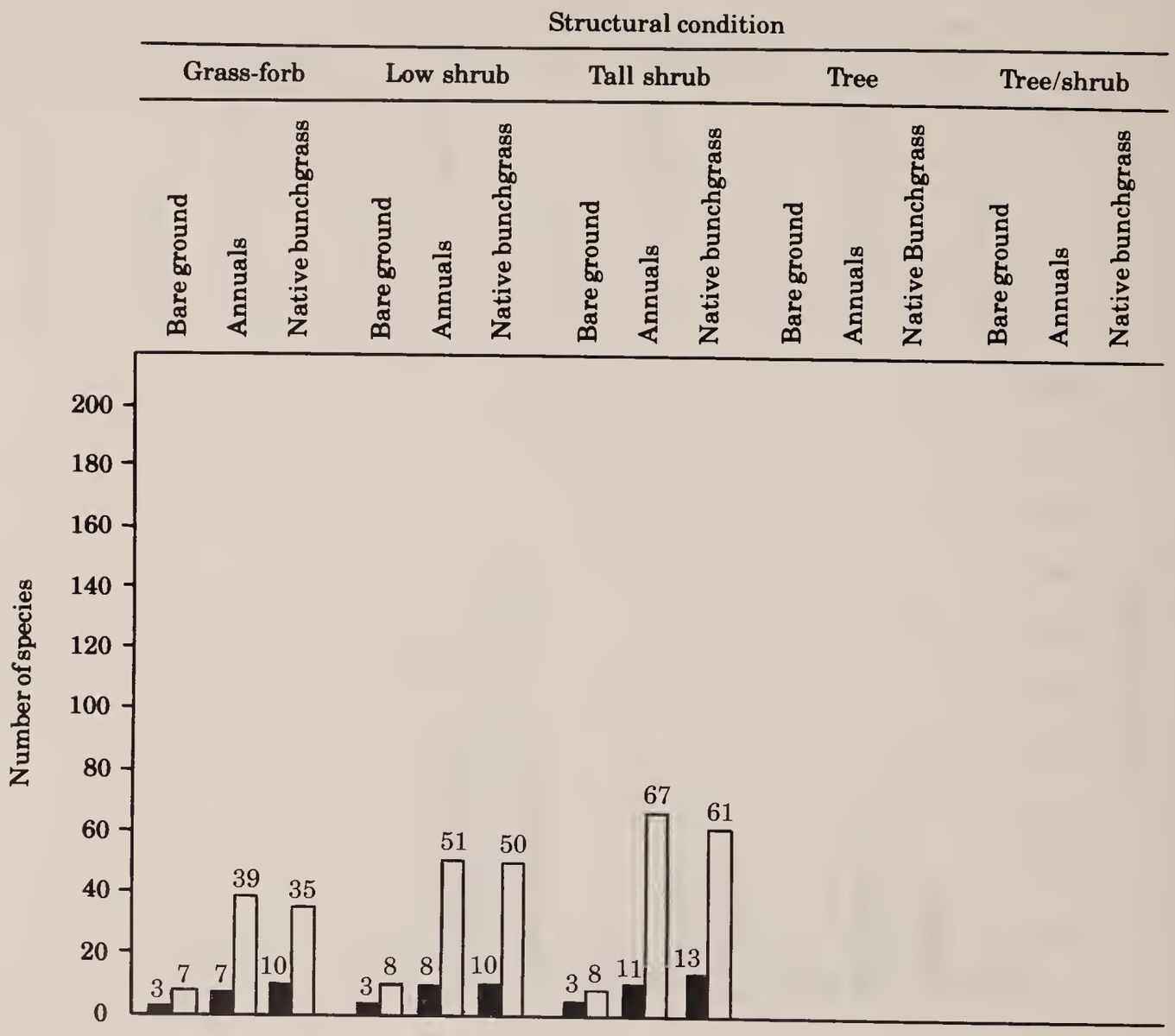
Plant community: Black greasewood/grass



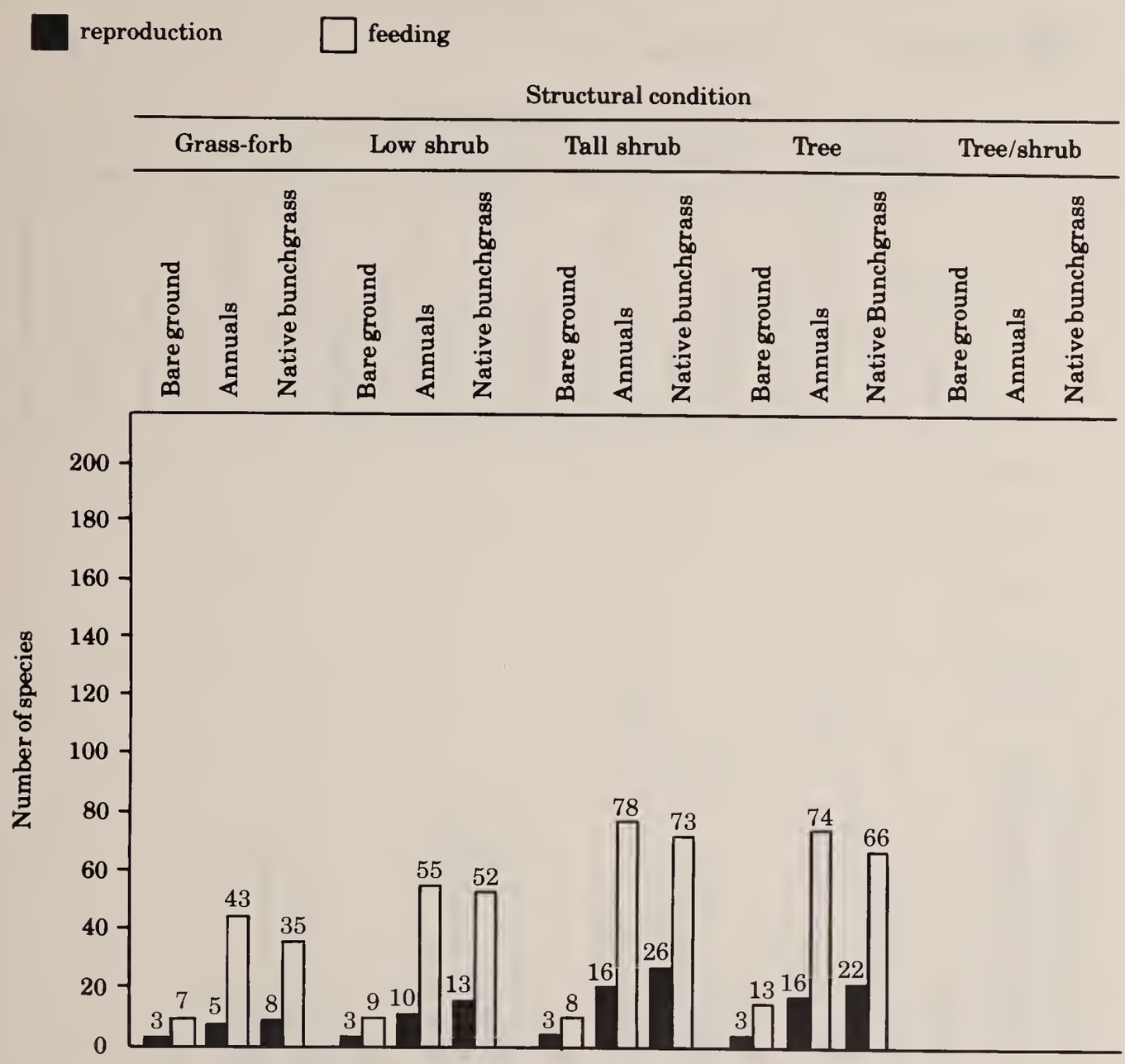
Plant community: Tall sagebrush/bunchgrass



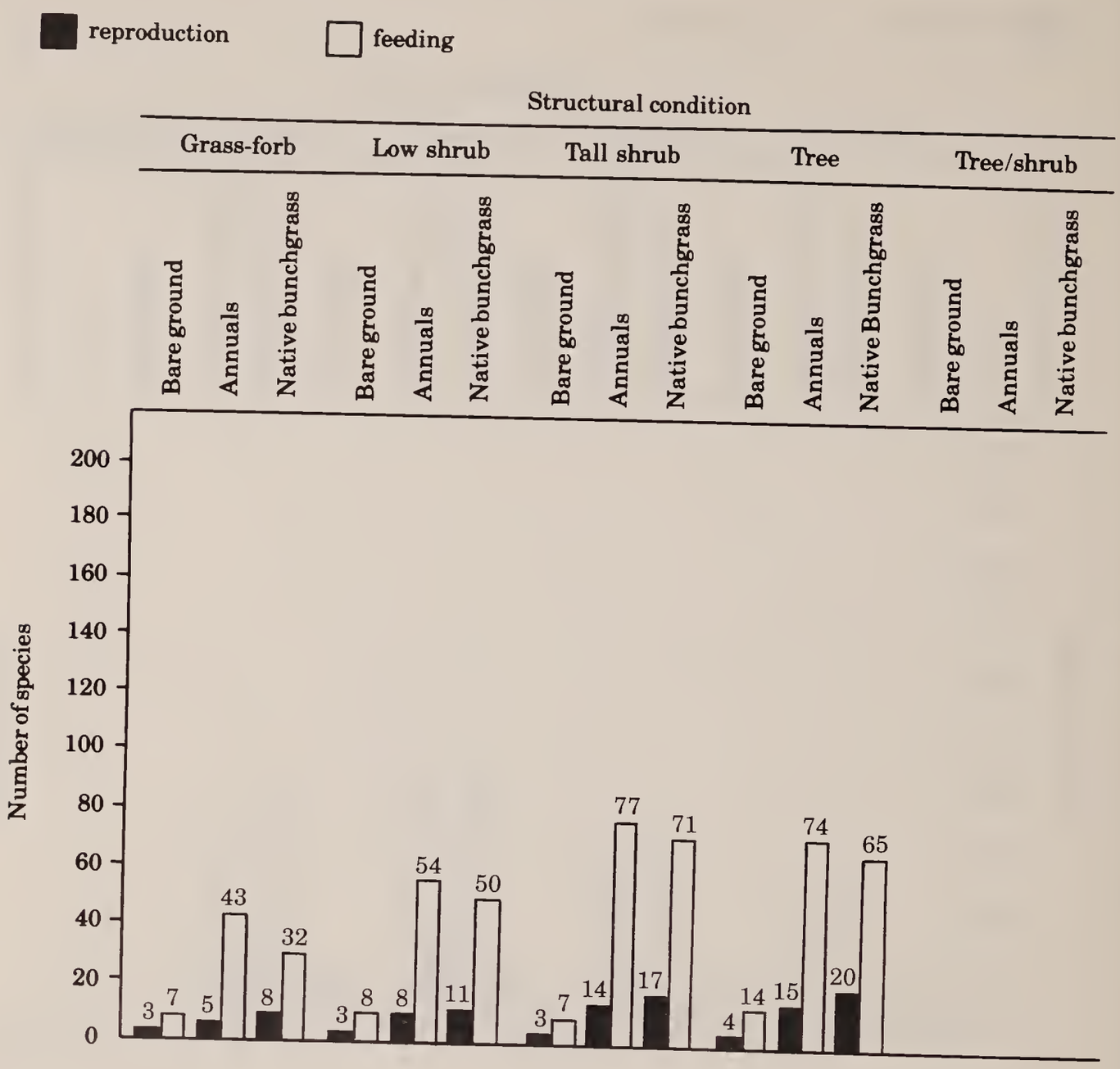
Plant community: Squaw apple/bunchgrass



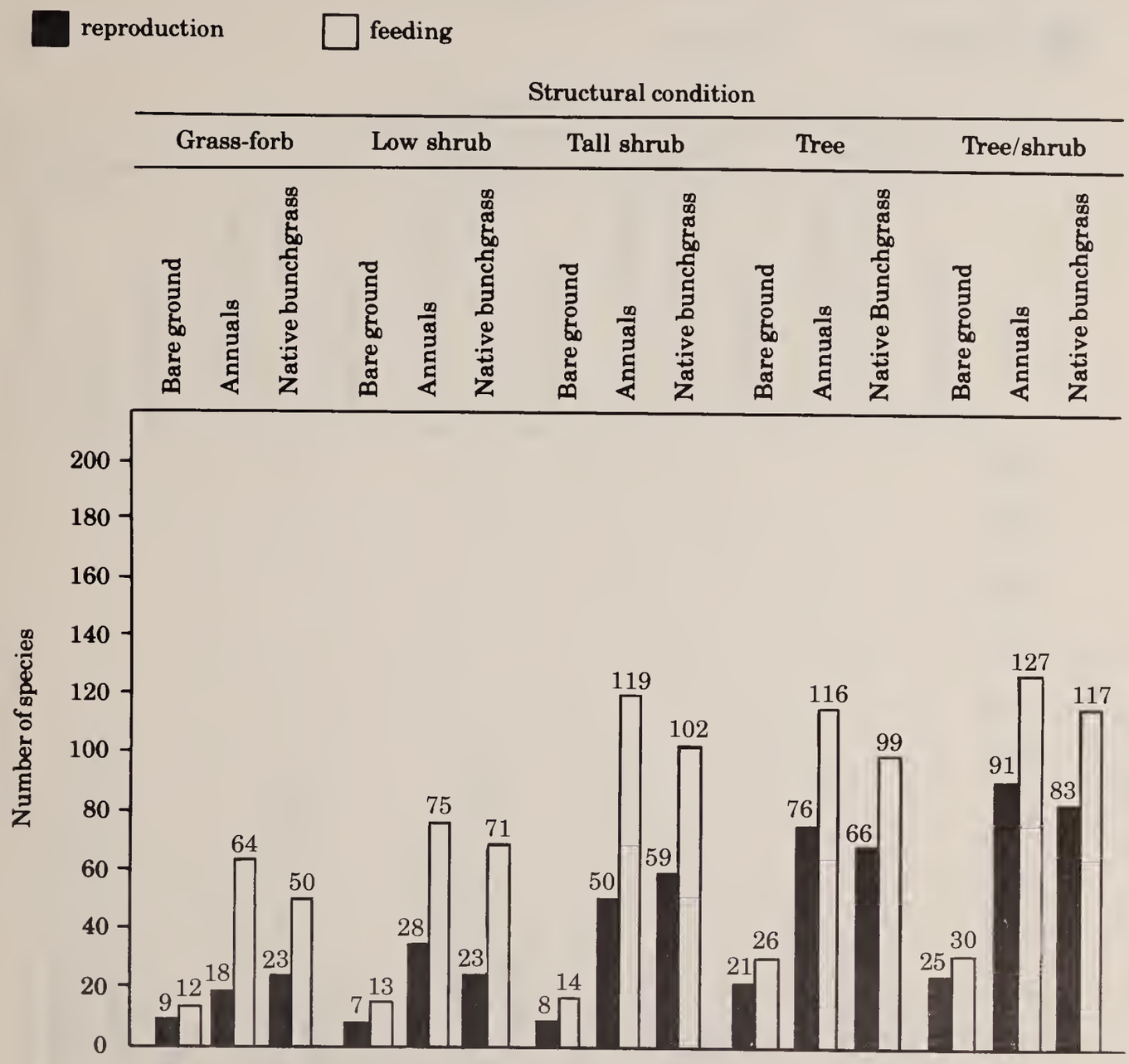
Plant community: Curlleaf mountainmahogany/bunchgrass



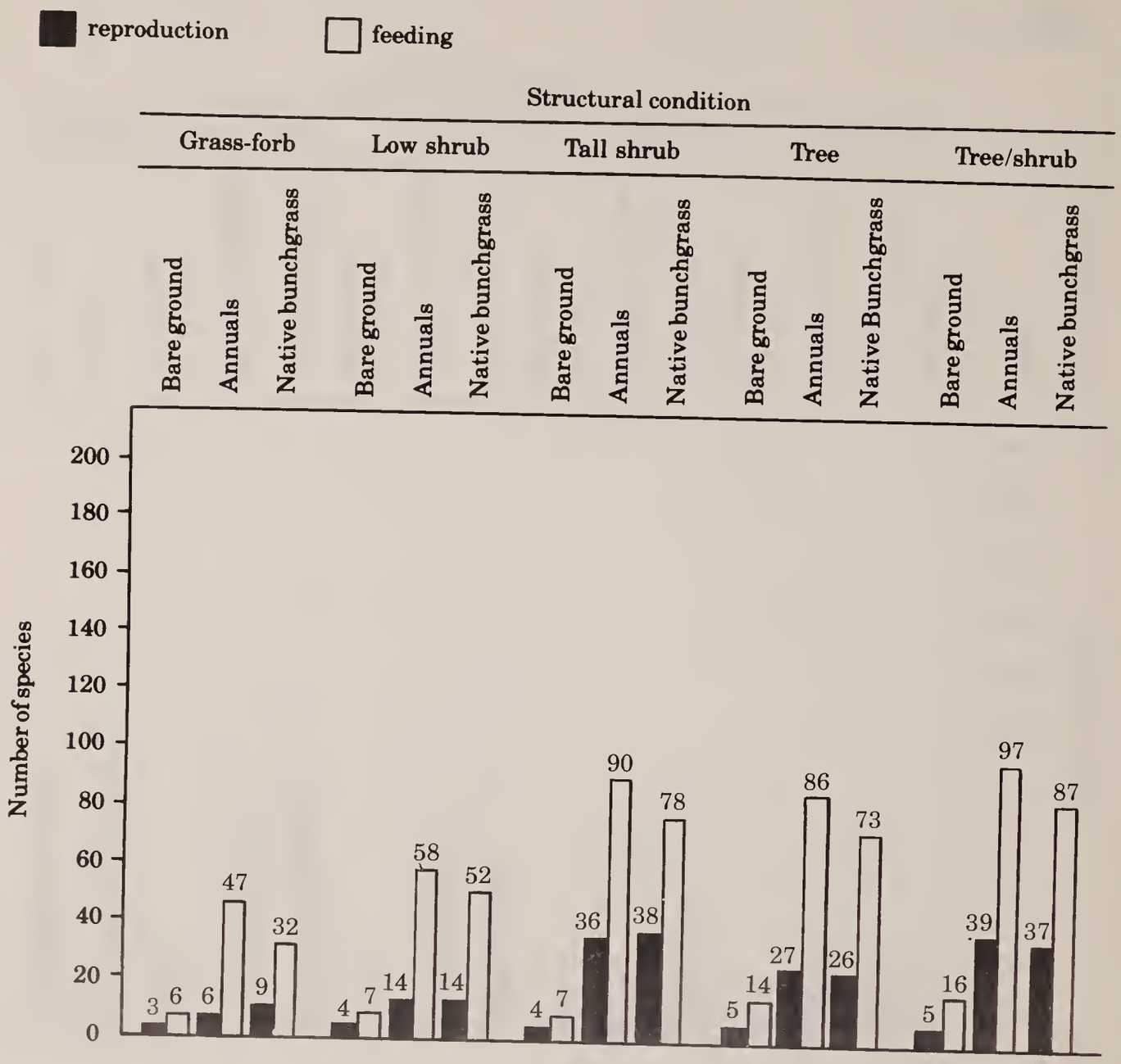
Plant community: Curlleaf mountainmahogany/pinegrass



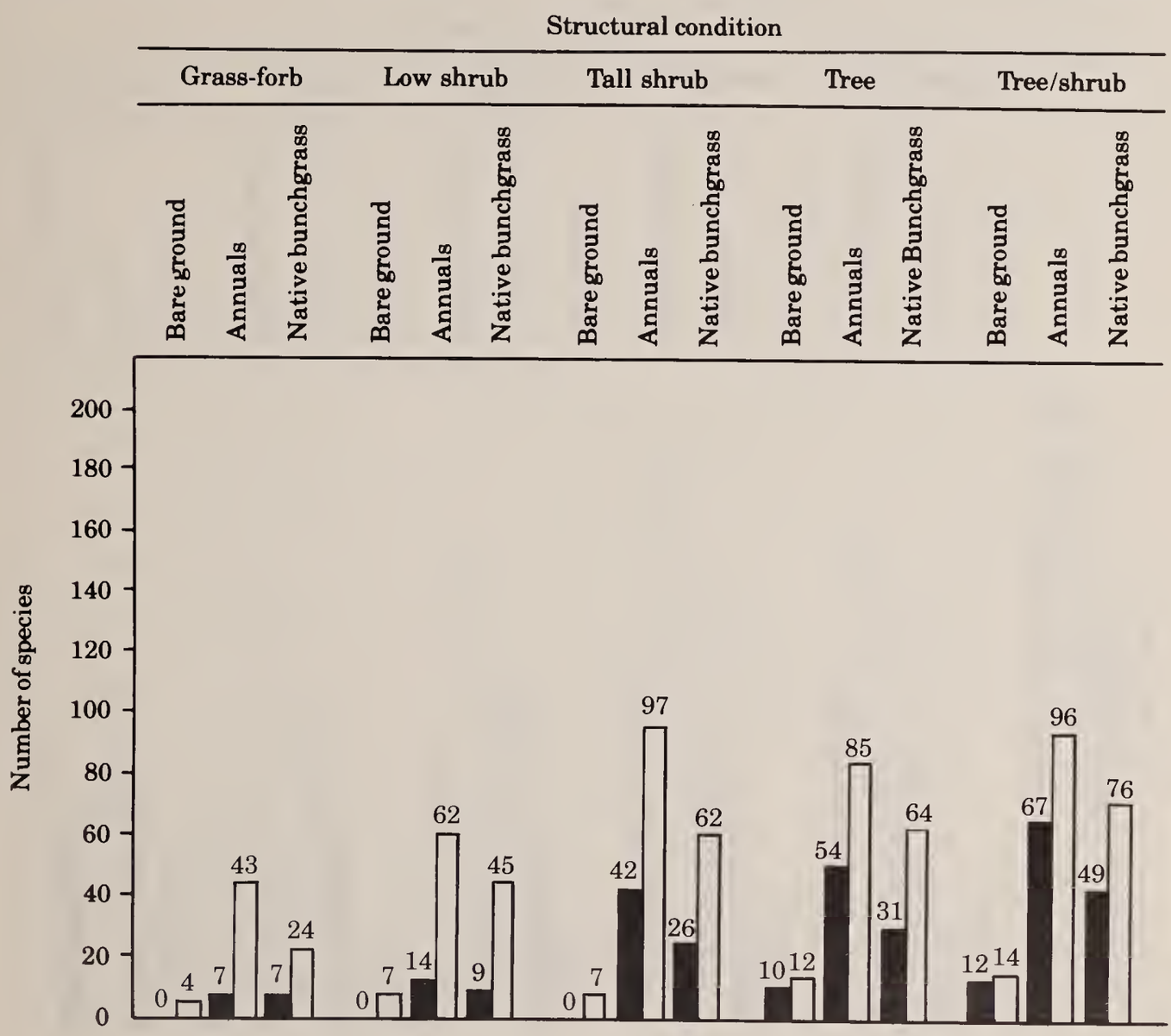
Plant community: Juniper/sagebrush/bunchgrass



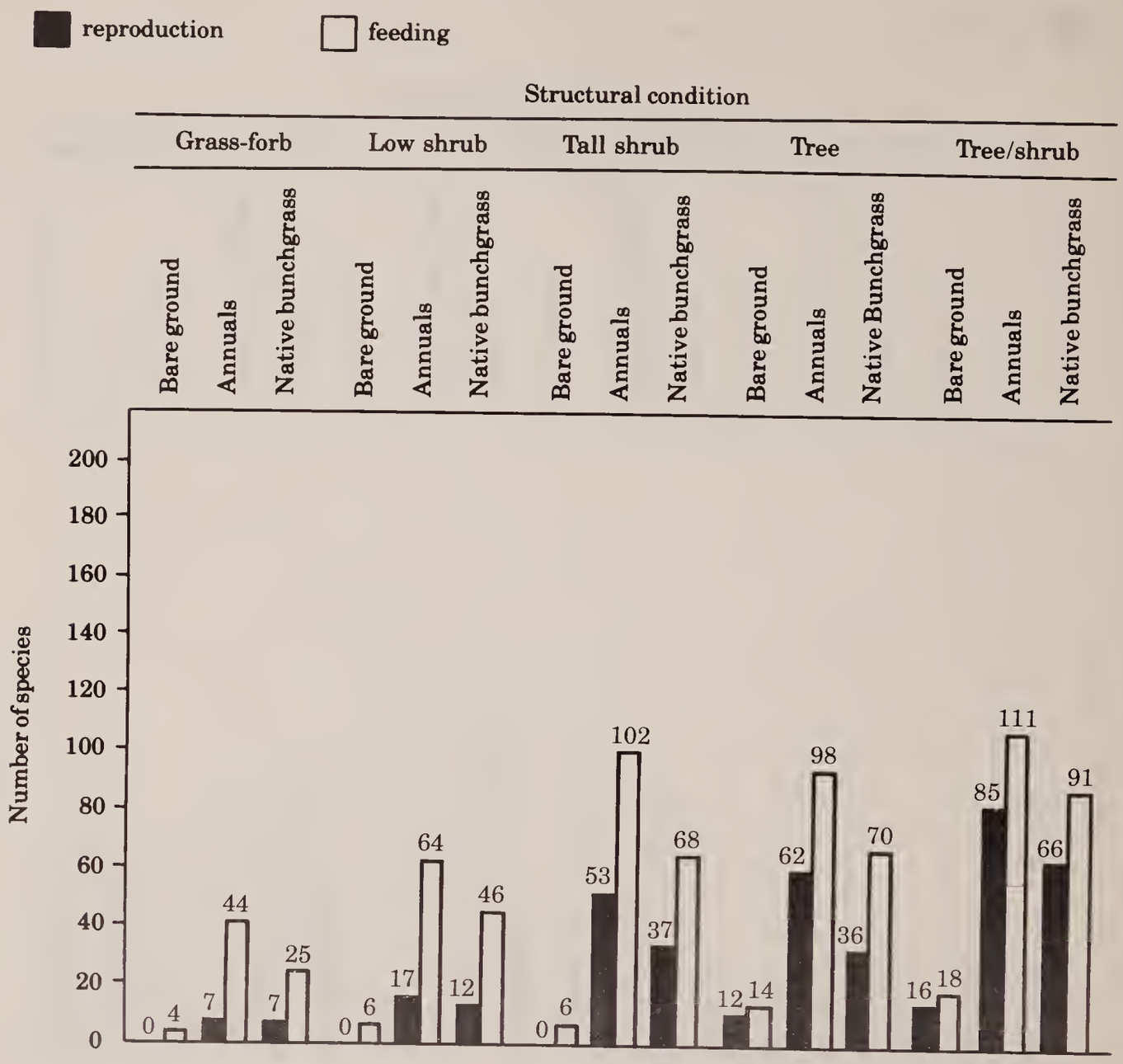
Plant community: Curlleaf mountainmahogany/shrub



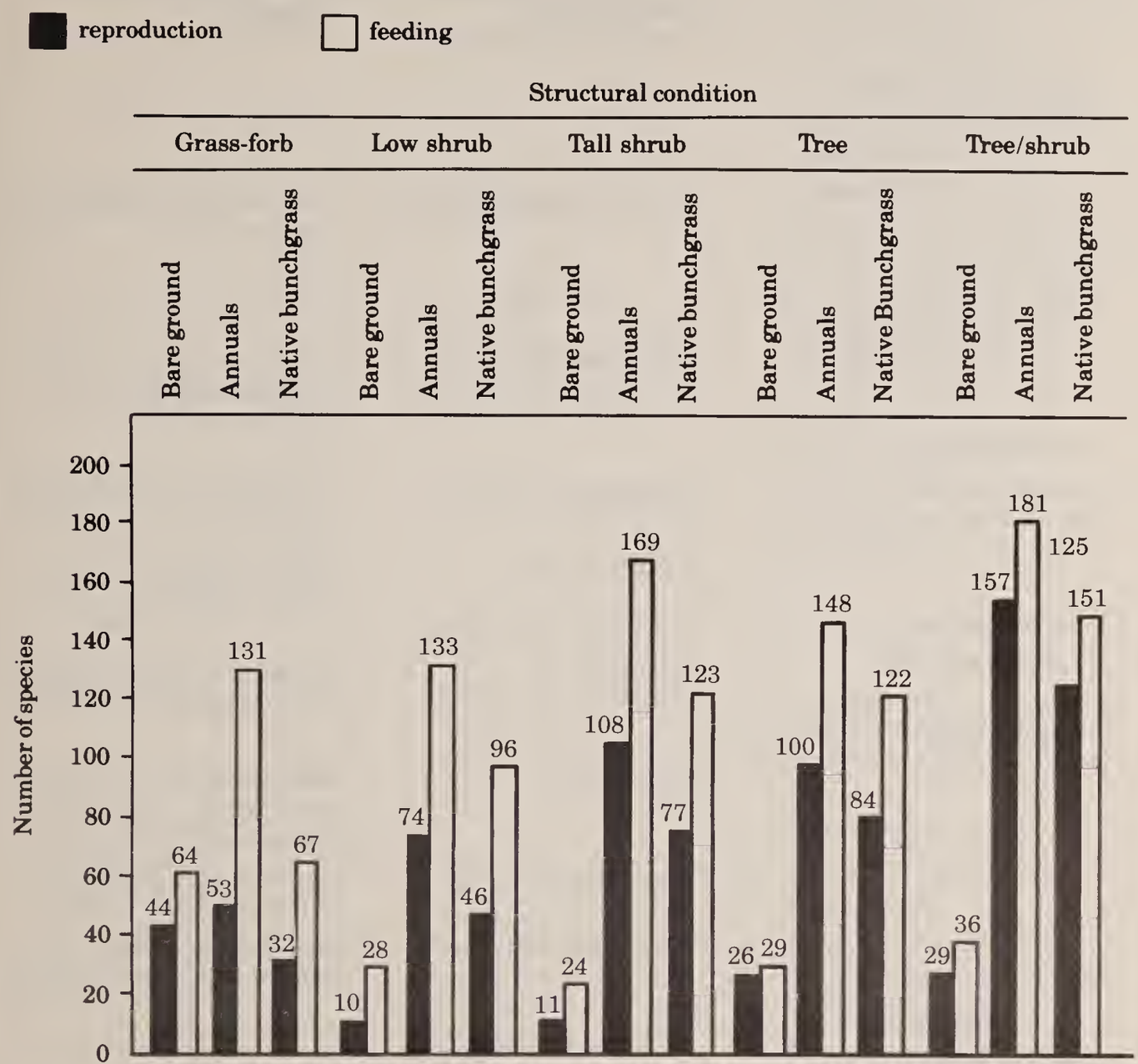
Plant community: Quaking aspen/grass



Plant community: Quaking aspen/mountain big sagebrush/bunchgrass



Plant community: Riparian



Appendix 10. Species-specific references used to construct appendix 1 (selected representative references).

Common name	Scientific name	References
AMPHIBIANS		
ORDER CAUDATA		Stebbins 1951, 1966
Family Ambystomidae		
long-toed salamander	*Ambystoma macrodactylum*	Anderson 1967, 1968, Farner and Kezer 1955
ORDER ANURA		
Family Pelobatidae		
Great Basin spadefoot	*Scaphiopus intermontanus*	Bragg 1945, Mayhew 1965, Pearson 1955, 1957, Wasserman 1958
Family Bufonidae		
western toad	*Bufo boreas*	Campbell 1970, Clarke 1974b, Lillywhite et al. 1973
Woodhouse toad	*Bufo woodhousei*	Bragg 1940, Clarke 1974a, Thornton 1960
Family Hylidae		
Pacific tree frog	*Hyla regilla*	Brown 1975, Jameson 1956, Jameson et al. 1970
Family Ranidae		
spotted frog	*Rana pretiosa*	Hollenbeck 1974, Licht 1975, Morris and Tanner 1969, Turner 1960
leopard frog	*Rana pipiens*	Hine et al. 1975, Pace 1974, Ruibal 1962
bullfrog	*Rana catesbeiana*	Darham and Bennett 1963, Sebetich 1969, Wiewandt 1969
REPTILES		
ORDER SQUAMATA		Ditmars 1936, Schmidt and Davis 1941, Stebbins 1954, 1966, Storm and Pimentel 1949, Tanner and Banta 1966, Wright and Wright 1957
Family Iguanidae		Pianka and Parker 1975
collared lizard	*Crotaphytus collaris*	Fitch 1956, Storm 1966, Talley 1974
leopard lizard	*Crotaphytus wislizeni*	Parker and Pianka 1976, Tanner and Krogh 1974

Common name	Scientific name	References
western fence lizard	*Sceloporus occidentalis*	Davis and Verbeek 1972, Goldberg 1973, 1974, 1975, Jameson and Allison 1976, Marcellini and Mackey 1970, Rose 1976
sagebrush lizard	*Sceloporus graciosus*	Derickson 1976, Stebbins and Robinson 1946, Tinkle 1973, Woodbury and Woodbury 1945
side-blotched lizard	*Uta stansburiana*	Nussbaum and Diller 1976, Parker 1974a, Parker and Pianka 1975, Tinkle 1967
desert horned lizard	*Phrynosoma platyrhinos*	Clark and Comanor 1976, Pianka and Parker 1975, Tanner and Krogh 1973
short-horned lizard	*Phrynosoma douglassi*	Goldberg 1971, Heath 1965, Knowlton and Baldwin 1953, Reeve 1952
Family Scinicidae		
western skink	*Eumeces skiltonianus*	Maser n.d., Tanner 1943, 1957
Family Teiidae		
western whiptail	*Cnemidophorus tigris*	Apslund 1974, Burkholder and Walker 1973, Parker 1972, Pianka 1970, Vitt and Ohmart 1977
Family Boidae		Schmidt and Davis 1941
rubber boa	*Charina bottae*	Peabody et al. 1975
Family Colubridae		Parker 1974b
yellow-bellied racer	*Coluber constrictor*	Brown and Parker 1976, Fitch 1963, Herzog and Burghardt 1974
striped whipsnake	*Masticophis taeniatus*	Parker 1974b, 1976, Parker and Brown 1972
gopher snake	*Pituophis melanoleucus*	Bogert and Roth 1966, Goldberg and Parker 1975, Greenwald 1974, Parker 1974b, Stull 1940
common garter snake	*Thamnophis sirtalis*	Aleksiuk 1977, Carpenter 1952, Fitch 1965
wandering garter snake	*Thamnophis elegans*	Fox 1948, 1951, Gregory 1978
western ground snake	*Sonora semiannulata*	Staedeli 1964, Stickel 1943, Storm 1947, Talley n.d.
night snake	*Hypsiglena torquata*	Clark and Lieb 1973

Common name	Scientific name	References
Family Viperidae		
Western rattlesnake	*Crotalus viridis*	Klauber 1972, Parker and Brown 1974, Rahn 1942
BIRDS		General – American Ornithologists' Union 1957, 1973a, 1973b, 1976, Bent 1926, 1961a, 1961b, 1962a, 1962b, 1962c, 1962d, 1963a, 1963b, 1963c, 1963d, 1963e, 1964a, 1964b, 1964c, 1964d, 1964e, 1964f, 1964g, 1965a, 1965b, 1968a, 1968b, 1968c, Bertrand and Scott 1973, Craighead and Craighead 1969, Flack 1976, Gabrielson and Jewett 1970, Gashwiler 1977, Jackman and Scott 1975, Olendorff and Stoddart 1974, Peterson 1961, Preston and Norris 1947, Reeves 1975
ORDER GAVIIFORMES		
Family Gaviidae		Scott et al. 1972
common loon	*Gavia immer*	McIntyre 1975, 1978, Olson and Marshall 1952
ORDER PODICIPEDIFORMES		
Family Podicipedidae		
red-necked grebe	*Podiceps grisegena*	Kebbe 1958, Kiss and Sterbetz 1973, Spahn 1978
horned grebe	*Podiceps auritus*	Faaborg 1976, Fjeldsa 1973a, 1973b, Sugden 1977
eared grebe	*Podiceps nigricollis*	Faaborg 1976, McAllister 1955, 1964, Storer et al. 1976
western grebe	*Aechmophorus occidentalis*	Feerer and Garrett 1977, Lawrence 1950, Lindvall 1976, Nuechterlein 1975
pied billed grebe	*Podilymbus podiceps*	Faaborg 1976, Glover 1953, Kirby 1976, Sealy 1978a
ORDER PELECANIFORMES		
Family Pelecanidae		
American white pelican	*Pelecanus erythrorhynchos*	Johnson and Sloan 1978, Knopf 1975, Sloan 1973

Common name	Scientific name	References
Family Phalacrocoracidae		
double-crested cormorant	*Phalacrocorax auritus*	Ellison and Cleary 1978, Lack 1945, Van Tets 1959
ORDER CICONIIFORMES		
Family Ardeidae		
great blue heron	*Ardea herodias*	Henny and Bethers 1971, Krebs 1974, Meyerrieks 1960, Nehls 1972
green heron	*Butorides striatus*	Kushlan 1976
common egret	*Casmerodius albus*	Jenni 1969, Pratt 1970
cattle egret	*Bubulcus ibis*	Blaker 1969, Burger 1978, Curry-Lindahl 1971
black-crowned night heron	*Nycticorax nycticorax*	Allen and Mangels 1938-39, Hoffman and Prince 1975, Nickell 1966, Wolford and Boag 1971
American bittern	*Botaurus lentiginosus*	Duebbert and Lokemoen 1977
least bittern	*Ixobrychus exilis*	Weller 1961
Family Threskiornithidae		
white-faced ibis	*Plegadis chihi*	Burger and Miller 1977, Ryder 1967b
ORDER ANSERIFORMES		Bellrose 1976
Family Anatidae		
whistling swan	*Olor columbianus*	Scott 1977, Sherwood 1960
Canada goose	*Branta canadensis*	Cooper 1978, Jarvis and Harris 1967, Martin 1964
white-fronted goose	*Anser albiforns*	Mickelson 1975
snow goose	*Chen caerulescens*	Cooch 1958, Dzubin and Stephen 1975, Kerbes 1975
Ross' goose	*Chen rossii*	Barry 1964, Ryder 1967a, 1972
mallard	*Anas platyrhynchos*	Anderson and Henny 1972, Anderson et al. 1974, Martin and Carney 1977, Pospahala et al. 1974
gadwall	*Anas strepera*	Gates 1962, Jensen 1949, Serie and Swanson 1976
common pintail	*Anas acuta*	Fuller 1953, Krapu 1977, Rundquist 1973, Smith 1970

Common name	Scientific name	References
green-winged teal	*Anas crecca*	Bennett and Bolen 1978, Moisan 1966
blue-winged teal	*Anas discors*	Swanson and Meyer 1977, Swanson et al. 1974, Wheeler 1965
cinnamon teal	*Anas cyanoptera*	Connelly 1978, Spencer 1953
American wigeon	*Anas americana*	Gates 1958, 1962
northern shoveler	*Anas clypeata*	Girard 1939, March 1967, Poston 1974
wood duck	*Aix sponsa*	Gilmer et al. 1978, McGilvrey 1968, Wildl. Manage. Inst. 1966
redhead	*Aythya americana*	McKnight 1974, Michot 1976, Weller 1964
ring-necked duck	*Aythya collaris*	Marshall and Duebbert 1965, Mendall 1958
canvasback	*Aythya valisineria*	Erickson 1948, Hochbaum 1944, Olson 1964, Sugden 1978
greater scaup	*Aythya marila*	Gehrman 1951
lesser scaup	*Aythya affinis*	Bartonek and Hickey 1969, Himes 1977, Rogers 1962
common goldeneye	*Bucephala clangula*	Gibbs 1961, McLaren 1962,
Barrow's goldeneye	*Bucephala islandica*	Griffee 1958, Myres 1957
bufflehead	*Bucephala albeola*	Erskine 1960, 1961, Griffee 1961a, Munro 1942
King eider	*Somateria spectabilis*	
oldsquaw	*Clangula hyemalis*	Ellarson 1956, Rofritz 1977
ruddy duck	*Oxyura jamaicensis*	McKnight 1974, Misterek 1974,Siegfried 1977
hooded merganser	*Lophodytes cucullatus*	Griffee 1954, Kitchen 1968, Morse et al. 1969
common merganser	*Mergus merganser*	Erskine 1972, Miller and Barclay 1974
red-breasted merganser	*Mergus serrator*	Lingle and Schupbach 1977
ORDER FALCONIFORMES		Brown and Amadon 1968, Craighead and Craighead 1969
Family Cathartidae		
turkey vulture	*Cathartes aura*	Coles 1938, Jackson et al. 1978, Stewart 1977

Common name	Scientific name	References
Family Accipitridae		
northern goshawk	*Accipiter gentilis*	Reynolds 1978, Reynolds and Wight 1978
sharp-shinned hawk	*Accipiter striatus*	Brown 1973, Platt 1973
Cooper's hawk	*Accipiter cooperii*	Henny and Wight 1972, Meng 1952
red-tailed hawk	*Buteo jamaicensis*	Fitch et al. 1946, Gates 1972, Luttich et al. 1970
Swainson's hawk	*Buteo swainsoni*	Dunkle 1977, Fitzner 1978, Olendorff 1972
rough-legged hawk	*Buteo lagopus*	Schnell 1968, Springer 1975
ferruginous hawk	*Buteo regalis*	Wakeley 1974, Weston 1969, Woffinden 1975, Woffinden and Murphy 1977
golden eagle	*Aquila chrysaetos*	Beecham and Kochert 1975, McGahan 1968, Mosher and White 1976, Murphy et al. 1969, Seibert et al. 1976, Snow 1973c
bald eagle	*Haliaeetus leucocephalus*	Mathisen et al. 1977, Murphy 1977, Platt 1976, Snow 1973b, Steenhoff 1978
northern harrier	*Circus cyaneus*	Clark and Ward 1974, Duebbert and Lokemoen 1977, Hamerstrom 1969
Family Pandionidae		
osprey	*Pandion haliaetus*	Henny 1977, Henny et al. 1978, Melquist et al. 1978, Zarn 1974b
Family Falconidae		
prairie falcon	*Falco mexicanus*	Denton 1976, Ogden and Hornocker 1977, Parker 1973, Snow 1974b
peregrine	*Falco peregrinus*	Hickey 1969, Porter and White 1973, Snow 1972
merlin	*Falco columbarius*	Fox 1971, Hodson 1976, Trimble 1975a
American kestrel	*Falco sparverius*	Enderson 1960, Henny et al. 1976, Smith et al. 1972

Common name	Scientific name	References
ORDER GALLIFORMES		
Family Tetraonidae		
blue grouse	*Dendragapus obscurus*	Bendell and Elliott 1967, Donaldson and Bergerud 1974, Severson 1978, Weber et al. 1974
ruffed grouse	*Bonasa umbellus*	Bump et al. 1947, Moulton and Vanderschaegen 1974, Robertson 1976
sage grouse	*Centrocercus urophasianus*	Braun et al. 1977, Gray 1967, Wallestad 1975
Family Phasianidae		
California quail	*Lophortyx californicus*	Anthony 1970, Storer et al. 1942, Sumner 1935
mountain quail	*Oreortyx pictus*	Gutierrez 1975, Lahnum 1944, Ormiston 1966
chukar	*Alectoris chukar*	Galbreath and Moreland 1953, Mackie and Buechner 1963, Molini 1976
gray partridge	*Perdix perdix*	McKinney 1966, Weigand 1977, Westerskov 1949
ring-necked pheasant	*Phasianus colchicus*	Allen 1956, Crouse 1941, Olsen 1977
ORDER GRUIFORMES		
Family Gruidae		
sandhill crane	*Grus canadensis*	Drewien and Bizeau 1974, Mullins and Bizeau 1978, Walkinshaw 1949
Family Rallidae		
Virginia rail	*Rallus limicola*	Billard 1947, Glahn 1974, Horak 1964, Reeves 1975
sora	*Porzana carolina*	see Virginia rail
American coot	*Fulica americana*	Crawford 1977, Frederickson 1970, Jahn 1965, Jones 1940
ORDER CHARADRIIFORMES		Stout 1967
Family Charadriidae		Gerstenberg and Jurek 1972
semi-palmated plover	*Charadrius semipalmatus*	

Common name	Scientific name	References
snowy plover	*Charadrius alexandrinus*	Oreg. Dep. Fish & Wildl. 1977, Purdue 1974
killdeer	*Charadrius vociferus*	Bunni 1959, Lenington and Mace 1975, Mace 1978
mountain plover	*Charadrius montanus*	Graul 1975, Laun 1957
Family Scolopacidae		Gerstenberg and Jurek 1972
common snipe	*Capella gallinago*	Reeves 1975, Tuck 1972, Winegardner 1976
long-billed curlew	*Numeninus americanus*	Bicak 1977, Bucher 1978, McCallum et al. 1977, Sadler and Maher 1976
spotted sandpiper	*Actitis macularia*	Nelson 1939
solitary sandpiper	*Tringa solitaria*	
greater yellowlegs	*Tringa melanoleuca*	
lesser yellowlegs	*Tringa flavipes*	
willet	*Catoptrophorus semipalmatus*	
pectoral sandpiper	*Calidris melanotos*	Pitelka 1959
Baird's sandpiper	*Calidris bairdii*	
least sandpiper	*Calidris minutilla*	
western sandpiper	*Calidris mauri*	
long-billed dowitcher	*Limnodromus scolopaceus*	
marbled godwit	*Limosa fedoa*	
Family Recurvirostridae		Gerstenberg and Jurek 1972, Wetmore 1925
American avocet	*Recurvirostra americana*	Bucher 1978, Gibson 1971
black-necked stilt	*Himantopus mexicanus*	
Family Phalaropodidae		Wetmore 1925
Wilson's phalarope	*Steganopus tricolor*	Burger and Howe 1975, Höhn 1967, Johns 1969
northern phalarope	*Lobipes lobatus*	Cole 1943, Hohn 1971, Tinbergen 1935
Family Laridae		
herring gull	*Larus argentatus*	Hunt 1972
California gull	*Larus californicus*	Greenhalgh 1952, Vermeer 1970

Common name	Scientific name	References
ring-billed gull	*Larus delawarensis*	Broadbooks 1961, Miller and Emlen 1975, Vermeer 1970
Franklin's gull	*Larus pipixcan*	Burger 1974, Jewett 1949
Bonaparte's gull	*Larus philadelphia*	
Forster's tern	*Sterna forsteri*	McNicholl 1971, Salt and Willard 1971, Storey 1977
Caspian tern	*Sterna caspia*	
black tern	*Chlidonias niger*	Einarsen 1941
ORDER COLUMBIFORMES		
Family Columbidae		
rock dove	*Columba livia*	Kindschy 1964, Murton et al. 1972, 1974
mourning dove	*Zenaida macroura*	Dolton 1977, Miles 1976, Ruos and Dolton 1977, U.S. Fish and Wildl. Serv. 1962
ORDER CUCULIFORMES		
Family Cuculidae		
yellow-billed cuckoo	*Coccyzus americanus*	Quaintance 1944
ORDER STRIGIFORMES		Burton 1973, Craighead and Craighead 1969
Family Tytonidae		
barn owl	*Tyto alba*	Henny 1969, Rudolph 1978 Smith and Marti 1976, Smith et al. 1974, Stewart 1952
Family Strigidae		
common screech owl	*Otus asio*	Nowicki 1974, Smith and Wilson 1971, VanCamp and Henny 1975
flammulated owl	*Otus flammeolus*	Balda et al. 1975, Marshall 1939, Winter 1974
great horned owl	*Bubo virginianus*	Baumgartner 1939, Rusch et al. 1972, Stewart 1969
pygmy owl	*Glaucidium gnoma*	Burton 1973
burrowing owl	*Athene cunicularia*	Collins and Landry 1977, Maser et al. 1971, Zarn 1974a
long-eared owl	*Asio otus*	Glue 1977, Maser et al. 1970, Sonnenberg and Powers 1976

Common name	Scientific name	References
short-eared owl	*Asio flammeus*	Banfield 1947, Clark 1975, Marti 1974
Saw-whet owl	*Aegolius acadicus*	Forbes and Warner 1974, Kebbe 1959, Woods 1972
ORDER CAPRIMULGIFORMES		Trimble 1975b
Family Caprimulgidae		
poorwill	*Phalaenoptilus nuttallii*	Horn and Marshall 1975
common nighthawk	*Chordeiles minor*	Armstrong 1965, Dexter 1961, Rust 1947, Selander 1954
ORDER APODIFORMES		Trimble 1975b
Family Apodidae		
black swift	*Cypseloides niger*	
Vaux's swift	*Chaetura vauxi*	Baldwin and Hunter 1963, Baldwin and Zaczkowski 1963, Griffee 1961b, Thompson 1977
white-throated swift	*Aeronautes saxatalis*	Weber 1975
Family Trochilidae		Greenwalt 1960
black-chinned hummingbird	*Archilochus alexandri*	
broad-tailed hummingbird	*Selasphorus platycercus*	Calder 1973, Calder and Booser 1973, Lyon 1973
rufous hummingbird	*Selasphorus rufus*	Gass et al. 1976, Horvath 1964
calliope hummingbird	*Stellula calliope*	Calder 1971, 1973
Anna's hummingbird	*Calypte anna*	Pitelka 1951a, Stiles 1971, Stiles and Wolf 1973
ORDER CORACIIFORMES		
Family Alcedinidae		Trimble 1975b
belted kingfisher	*Megaceryle alcyon*	Hamas 1974, Kilham 1974
ORDER PICIFORMES		Williams 1975, Williams and Batzli 1979
Family Picidae		Conner 1973, Conner et al. 1975, 1976, Jackman 1974
common flicker	*Colaptes auratus*	Anderson 1972, Conner 1973
yellow-bellied sapsucker	*Sphyrapicus varius*	Erskine and McLaren 1972, Kilham 1971a, Lawrence 1967
Williamson's sapsucker	*Sphyrapicus thyroideus*	Crockett and Hansley 1977, Michael 1936

Common name	Scientific name	References
Lewis' woodpecker	*Picoides lewis*	Bock 1970, Bock et al. 1971
hairy woodpecker	*Picoides villosus*	Kilham 1968a, Lawrence 1967, Staebler 1949
downy woodpecker	*Picoides pubescens*	Jackson 1970, Lawrence 1967, Staebler 1949
white-headed woodpecker	*Picoides albolarvatus*	Ligon 1973
ORDER PASSERIFORMES		Verner and Willson 1969
Family Tyrannidae		Trimble 1975b
eastern kingbird	*Tyrannus tyrannus*	Dick and Rising 1965, Hespenheide 1964, Morehouse and Brewer 1968
western kingbird	*Tyrannus verticalis*	Dick and Rising 1965, Ohlendorf 1974
ash-throated flycatcher	*Myiarchus cinerascens*	
Say's phoebe	*Sayornis saya*	Ohlendorf 1976, Whitaker 1974
Genus *Empidonax*		Ashmole 1968
willow flycatcher	*Empidonax traillii*	Aldrich 1955, King 1955, Robbins 1974
Hammond's flycatcher	*Empidonax hammondii*	Beaver and Baldwin 1975, Davis 1954, Manuwal 1970
gray flycatcher	*Empidonax wrightii*	Johnson 1963, Lavers 1975, Russell and Woodbury 1941
western flycatcher	*Empidonax difficilis*	Brodkorb 1949, Davis et al. 1963
western wood pewee	*Contopus sordidulus*	
olive-sided flycatcher	*Nuttallornis borealis*	
Family Alaudidae		
horned lark	*Eremophila alpestris*	Beason and Franks 1974, Pickwell 1931, Verbeek 1967
Family Hirundinidae		Trimble 1975b
violet-green swallow	*Tachycineta thalassina*	Combellack 1954
tree swallow	*Iridoprocne bicolor*	Chapman 1935, Kuerzi 1940-41
bank swallow	*Riparia riparia*	Freer 1977, Petersen 1955, Stoner 1936
rough-winged swallow	*Stelgidopteryx ruficollis*	Lunk 1962

Common name	Scientific name	References
barn swallow	*Hirundo rustica*	Henny 1972, Jackson and Burchfield 1975, Mason 1953
cliff swallow	*Petrochelidon pyrrhonota*	Buss 1942, Emlen 1952, Mayhew 1958
Family Corvidae		Jollie 1976, Trimble 1975b, Turcek and Kelso 1968
gray jay	*Perisoreus canadensis*	Aldrich 1943, Ouellet 1970, Rutter 1969
Steller's jay	*Cyanocitta stelleri*	Brown 1963
scrub jay	*Aphelocoma coerulescens*	Pitelka 1951b
black-billed magpie	*Pica pica*	Bock and Lepthien 1975, Brown 1957, Erpino 1968, Jones 1960
northern raven	*Corvus corax*	Larsen and Dietrich 1970, Maser 1975, Montevecchi 1978, Stiehl 1978
American crow	*Corvus brachyrhynchos*	Good 1952, Montevecchi 1976, Platt 1956
pinyon jay	*Gymnorhinus cyanocephalus*	Balda and Bateman 1971, Bateman and Balda 1973, Ligon and Martin 1974
Clark's nutcracker	*Nucifraga columbiana*	Giuntoli and Mewaldt 1978, Mewaldt 1956, Tomback 1977
Family Paridae		Trimble 1975b
black-capped chickadee	*Parus atricapillus*	Henny 1972, Kessel 1976, Odum 1941a, 1941b, Sturman 1968
mountain chickadee	*Parus gambeli*	Dixon 1961, Kluyver 1961
bushtit	*Psaltriparus minimus*	Ervin 1977
Family Sittidae		
white-breasted nuthatch	*Sitta carolinensis*	Kilham 1968b, 1971a, 1971b, 1972
red-breasted nuthatch	*Sitta canadensis*	Anderson 1976a, Kilham 1973, Stallcup 1968
Family Certhiidae		
brown creeper	*Certhia familiaris*	Apfelbaum and Haney 1977, McClelland 1975, McClelland and Frissell 1975
Family Cinclidae		
dipper	*Cinclus mexicanus*	Parsons 1975, Price and Bock 1973, Thut 1970

Common name	Scientific name	References
Family Troglodytidae		Trimble 1975b
house wren	*Troglodytes aedon*	Kendeigh 1941, Kroodsma 1973
winter wren	*Troglodytes troglodytes*	Armstrong 1956, Evenden 1950
marsh wren	*Cistothorus palustris*	Kale 1965, Verner 1963, 1975, Verner and Engelsen 1970
canyon wren	*Catherpes mexicanus*	Grinnell and Behle 1935
rock wren	*Salpinctes obsoletus*	Knowlton and Harmston 1942, Kroodsma 1975
Family Mimidae		Trimble 1975b
gray catbird	*Dumetella carolinensis*	Fletcher and Smith 1978, Harcus 1973
brown thrasher	*Toxostoma rufum*	
sage thrasher	*Oreoscoptes montanus*	Reynolds and Rich 1978, Rich 1978b
Family Turdidae		Trimble 1975b
American robin	*Turdus migratorius*	Farner 1949, Henny 1972, James and Shugart 1974
varied thrush	*Ixoreus naevius*	Martin 1970a
hermit thrush	*Catharus guttatus*	Cochran et al. 1967, Morse 1972, Noon 1977
Swainson's thrush	*Catharus ustulatus*	Morse 1972, Noon 1977
veery	*Catharus fuscescens*	Aldrich 1939, Bertin 1977, Noon 1977
western bluebird	*Sialia mexicana*	Herlugson 1978, Pinkowski 1978, Pinkowski and Zeleny 1975
mountain bluebird	*Sialia currucoides*	Haecker 1948, Pinkowski 1978, Pinkowski and Zeleny 1975, Power 1966
Townsend's solitaire	*Myadestes townsendi*	Lederer 1977a, 1977b, Solomonson and Balda 1977
Family Sylviidae		Trimble 1975b
blue-gray gnatchatcher	*Polioptila caerulea*	
ruby-crowned kinglet	*Regulus calendula*	
Family Motacillidae		
water pipit	*Anthus spinoletta*	Gibb 1956, Verbeek 1970

Common name	Scientific name	References
Family Bombycillidae		
bohemian waxwing	*Bombycilla garrulus*	Bakke 1977, Knapton and Sexton 1978
cedar waxwing	*Bombycilla cedrorum*	Burleigh 1963, Gollob and Pulich 1978
Family Laniidae		
northern shrike	*Lanius excubitor*	Cade 1962, 1967, Davis 1974
loggerhead shrike	*Lanius ludovicianus*	Craig 1978, Porter et al. 1975, Smith 1973a, 1973b
Family Sturnidae		
European starling	*Sturnus vulgaris*	Bray et al. 1975, DeHaven and DeHaven 1973, Planck 1967
Family Vireonidae		Chapin 1925, Trimble 1975b
solitary vireo	*Vireo solitarius*	Hamilton 1962, James 1973, 1976
red-eyed vireo	*Vireo olivaceus*	Lawrence 1953, Southern 1958, Williamson 1971
warbling vireo	*Vireo gilvus*	James 1976
Family Parulidae		Griscom and Sprunt 1957, Trimble 1975b
orange-crowned warbler	*Vermivora celata*	Ficken and Ficken 1962a
Nashville warbler	*Vermivora ruficapilla*	Lawrence 1948, Roth 1977
yellow warbler	*Dendroica petechia*	Ficken and Ficken 1965, Morse 1973
yellow-rumped warbler	*Dendroica coronata*	Hubbard 1969
black-throated gray warbler	*Dendroica nigrescens*	
Townsend's warbler	*Dendroica townsendi*	
ovenbird	*Seiurus aurocapillus*	Littlefield and McLaury 1975, Stenger 1958, Zach and Falls 1979
MacGillivray's warbler	*Oporornis tolmiei*	
common yellowthroat	*Geothlypis trichas*	Hofslund 1959, Wunderle 1978
yellow-breasted chat	*Icteria virens*	Ficken and Ficken 1962b, Stewart 1953, Thompson and Nolan 1973
Wilson's warbler	*Wilsonia pusilla*	Stewart et al. 1977
American redstart	*Setophaga ruticilla*	Ficken and Ficken 1967, McLaren 1975, Morse 1973

Common name	Scientific name	References
Family Ploceidae		
house sparrow	*Passer domesticus*	Kendeigh 1973, Summers-Smith 1967, 1968
Family Icteridae		Crase and DeHaven 1975, Trimble 1975b
bobolink	*Dolichonyx oryzivorus*	Martin 1970b, 1974
western meadowlark	*Sturnella neglecta*	Anderson and Merrill 1967, Knowlton and Maddock 1943, Lanyon 1957
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Lederer 1978, Willson 1966, Willson and Orians 1963
red-winged blackbird	*Agelaius phoeniceus*	Cutright 1973, Dolbeer 1978, Krapu 1978, Robertson 1972
northern oriole	*Icterus galbula*	Pleasants 1977, 1979, Schaefer 1976
Brewer's blackbird	*Euphagus cyanocephalus*	Hansen and Carter 1963, Horn 1968, Stepney 1975, Williams 1952
brown-headed cowbird	*Molothrus ater*	Friedmann 1963, Hill 1976, Payne 1976
Family Thraupidae		Trimble 1975b
western tanager	*Piranga ludoviciana*	
Family Fringillidae		Trimble 1975b
rose-breasted grosbeak	*Pheucticus ludovicianus*	Kroodsma 1974, Lemon and Chatfield 1973
black-headed grosbeak	*Pheucticus melanocephalus*	Kroodsma 1974
indigo bunting	*Passerina cyanea*	Emlen et al. 1975, Wells 1958, Whitmore 1975
lazuli bunting	*Passerina amoena*	Emlen et al. 1975, Thompson 1976, Whitmore 1975
evening grosbeak	*Hesperiphona vespertina*	Balph and Balph 1976, Blais and Parks 1964, Dexter 1975
purple finch	*Carpodacus purpureus*	Pulliam and Enders 1971
Cassin's finch	*Carpodacus cassinii*	Balph 1978, Herman 1971, Samson 1976
house finch	*Carpodacus mexicanus*	Thompson 1960
common redpoll	*Carduelis flammea*	Evans 1969, Kennard 1976, Pohl and West 1976, 1978

Common name	Scientific name	References
pine siskin	*Carduelis pinus*	Eriksson 1970, Harris 1975
American goldfinch	*Carduelis tristis*	Holcomb 1969, Miller 1978, Nickell 1951
lesser goldfinch	*Carduelis psaltria*	
green-tailed towhee	*Pipilo chlorura*	
rufous-sided towhee	*Pipilo erythrophthalmus*	Baumann 1959, Davis 1960, Greenlaw 1978
savannah sparrow	*Passerculus sandwichensis*	Bradley 1973, Dixon 1978, Welsh 1975, Wiens 1973
grasshopper sparrow	*Ammodramus savannarum*	Pulliam and Mills 1977, Smith 1963, Wiens 1973
vesper sparrow	*Pooecetes gramineus*	Best 1972, Pulliam and Mills 1977, Simpson 1978
lark sparrow	*Chondestes grammacus*	Renwald 1977
sage sparrow	*Amphispiza belli*	Braun et al. 1976, Moldenhauer 1970, Moldenhauer and Wiens 1970, Rich 1978a
northern junco	*Junco hyemalis*	Balph 1977, Gottfried and Franks 1975, Sabine 1959
American tree sparrow	*Spizella arborea*	Anderson 1973, Heydweiller 1935, Stenger 1965, Weeden 1965
chipping sparrow	*Spizella passerina*	Hebrand 1974, Klopfer 1965, Pulliam and Mills 1977
Brewer's sparrow	*Spizella breweri*	Best 1972, Rich 1978a
white-crowned sparrow	*Zonotrichia leucophrys*	Cortopassi and Mewaldt 1965, Lewis 1975, Morton et al. 1972, Rees 1973
golden-crowned sparrow	*Zonotrichia atricapilla*	Balph 1976
fox sparrow	*Passerella iliaca*	Banks 1970
Lincoln's sparrow	*Melospiza lincolnii*	Miller 1939, Miller and McCabe 1935
song sparrow	*Melospiza melodia*	Knapton and Krebs 1974, Nice 1943, Tompa 1962
Lapland longspur	*Calcarius lapponicus*	
snow bunting	*Plectrophenax nivalis*	Nethersole-Thompson 1966, Tinbergen 1939

Common name	Scientific name	References
MAMMALS		General – Bailey 1936, Burt and Grossenheider 1964, Hall and Kelson 1959, Hansen 1956, Harvey 1976, McDaniel and Gardner 1977, McReynolds 1976, Mohr 1976
ORDER INSECTIVORA		
Family Soricidae		
Malheur shrew	*Sorex preblei*	Armstrong 1957, Hoffman and Fisher 1978, Verts 1975
wandering shrew	*Sorex vagrans*	Clothier 1955, Hooven et al. 1975, Ingles 1961, Terry 1978, Whitaker and Maser 1976
Merriam shrew	*Sorex merriami*	Gashwiler 1976, Johnson and Clanton 1954, Lindsay and Perry 1977
ORDER CHIROPTERA		Barbour and Davis 1969, Cross 1977, Saul et al. 1977
Family Vespertilionidae		
little brown myotis	*Myotis lucifugus*	Buchler 1976, Fenton 1970, Kunz et al. 1977, O'Farrell and Studier 1973, 1975
Yuma myotis	*Myotis yumanensis*	Dalquest 1947b
long-eared myotis	*Myotis evotis*	Dalquest 1948
fringed myotis	*Myotis thysanodes*	O'Farrell and Studier 1973, 1975
long-legged myotis	*Myotis volans*	Whitaker et al. 1977
California myotis	*Myotis californicus*	Krutzsch 1954, Whitaker et al. 1977
small-footed myotis	*Myotis leibi*	Fenton 1972, Tuttle and Heaney 1974
silver-haired bat	*Lasionycteris noctivagans*	Sealy 1978b, Whitaker et al. 1977, Whitaker et al. 1981
western pipistrelle	*Pipistrellus hesperus*	Cross 1965, Hoff and Riedesel 1969
big brown bat	*Eptesicus fuscus*	Christian 1956, Davis et al. 1968, Mills et al. 1975

Common name	Scientific name	References
hoary bat	*Lasiurus cinereus*	Constantine 1966, Findley and Jones 1964, Jones 1965, Poche and Bailie 1974, Poche and Ruffner 1975
spotted bat	*Euderma maculata*	Easterla 1971, Snow 1974a, U.S. Dep. Inter. 1973
western big-eared bat	*Plecotus townsendi*	Dalquest 1974a, Graham 1966, Humphrey and Kunz 1976, Pearson et al. 1952
pallid bat	*Antrozous pallidus*	Beck and Rudd 1960, Davis 1969, Orr 1954
ORDER LAGOMORPHA		
Family Leporidae		Hansen 1972
pygmy rabbit	*Sylvilagus idahoensis*	Orr 1940, Severaid 1950
mountain cottontail	*Sylvilagus nuttalli*	Chapman 1975, McKay and Verts 1978, Orr 1940
white-tailed jackrabbit	*Lepus townsendi*	Bear and Hansen 1966, James and Seabloom 1969a, 1969b
black-tailed jackrabbit	*Lepus californicus*	Blackburn 1968, Gross et al. 1974, Haskell and Reynolds 1947
ORDER RODENTIA		
Family Sciuridae		
least chipmunk	*Eutamias minimus*	Meredith 1976, Sheppard 1965, Skryja 1974
yellow-pine chipmunk	*Eutamias amoenus*	Broadbooks 1958, 1970a, 1970b
yellow-bellied marmot	*Marmota flaviventris*	Armitage 1975, Armitage and Downhower 1974, Garrott and Jenni 1978
antelope ground squirrel	*Ammospermophilus leucurus*	Bradley 1967, 1968
Townsend ground squirrel	*Spermophilus townsendi*	Dalquest 1948, Johnson 1977, Shaw 1921
Richardson ground squirrel	*Spermophilus richardsoni*	Michener 1977, Michener and Michener 1977, Zegers 1976
Belding ground squirrel	*Spermophilus beldingi*	Morton and Gallup 1975, Morton et al. 1974, Morton and Sherman 1978, Turner 1972

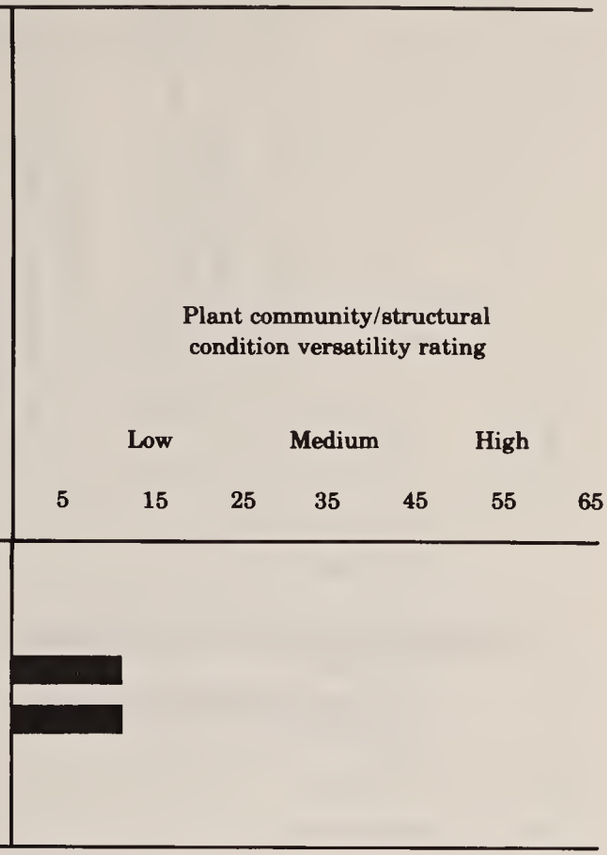
Common name	Scientific name	References
mantled ground squirrel	*Spermophilus lateralis*	Gordon 1943, Tevis 1952 Yousef and Bradley 1971
Family Geomyidae		
Townsend pocket gopher	*Thomomys townsendi*	Hall 1946, Horn 1923
northern pocket gopher	*Thomomys talpoides*	Anderson 1976b, Hansen and Beck 1968, Julander et al. 1969
Family Heteromyidae		
little pocket mouse	*Perognathus longimembris*	
Great Basin pocket mouse	*Perognathus parvus*	Hedlund et al. 1975, Kritzman 1974, O'Farrell et al. 1975, Scheffer 1938
dark kangaroo mouse	*Microdipodops megacephalus*	Ghiselin 1970, O'Farrell and Blaustein 1974
Ord kangaroo rat	*Dipodomys ordi*	Blaustein and Risser 1976, Jorgensen et al. 1980, Lemen and Rosenzweig 1978, Whitford 1976
chisel-toothed kangaroo rat	*Dipodomys microps*	Beatley 1976, Jorgensen 1963, Kenagy 1973
Family Castoride		
beaver	*Castor canadensis*	Ffolliott 1976, Leege 1968, Rutherford 1964
Family Cricetidae		
western harvest mouse	*Reithrodontomys megalotis*	Birkenholz 1967, Fisler 1971, Richens et al. 1974, Whitaker and Mumford 1972
canyon mouse	*Peromyscus crinitus*	Egoscue 1964, Lechleitner 1969
deer mouse	*Peromyscus maniculatus*	Blair 1943, King 1968, Kritzman 1974, Wirtz and Pearson 1960
northern grasshopper mouse	*Onychomys leucogaster*	Egoscue 1960, McCarty 1978, Ruffer 1965
desert woodrat	*Neotoma lepida*	Bleich and Schwartz 1975, Stones and Hayward 1968
bushy-tailed woodrat	*Neotoma cinerea*	Findley 1958, Johnson and Hansen 1979

Common name	Scientific name	References
Family Microtinae		
montane vole	*Microtus montanus*	Murie 1971, Murray 1965, Randall 1978
long-tailed vole	*Microtus longicaudus*	Beck and Anthony 1971, Randall 1978
sage vole	*Lagurus curtatus*	Clanton et al. 1971, Johnson et al. 1948, Maser et al. 1974, Maser and Strickler 1978
muskrat	*Ondatra zibethicus*	Kiviat 1978, Neal 1968, Sather 1958, Willner et al. 1975
Family Zapodidae		
western jumping mouse	*Zapus princeps*	Brown 1967, Cranford 1978, Jones et al. 1978, Stinson 1977
Family Erethizontidae		
porcupine	*Erethizon dorsatum*	Hoven 1971, Smith 1977
Family Canidae		
coyote	*Canis latrans*	Gier 1968, Knowlton 1972, Mathwig 1973
red fox	*Vulpes vulpes*	Sheldon 1949, Stanley 1963, Storm et al. 1976
kit fox	*Vulpes macrotis*	Benedict and Forbes 1979, Egoscue 1962, 1975, Laughrin 1970, Snow 1973a
Family Procyonidae		
raccoon	*Procyon lotor*	Fritzell 1978, Schneider et al. 1971, Urban 1970
Family Mustelidae		Hamilton 1933, Heidt et al. 1976
long-tailed weasel	*Mustela frenata*	Hall 1951
mink	*Mustela vison*	Errington 1943, Northcott et al. 1974, Shump et al. 1976a
badger	*Taxidea taxus*	Lindzey 1978, Sargeant and Warner 1972
spotted skunk	*Spilogale putorius*	Baker and Baker 1975, Crabb 1948, Patton 1974
striped skunk	*Mephitis mephitis*	Bailey 1971, Shump et al. 1975, Verts 1967
river otter	*Lutra canadensis*	Shump et al. 1976b, Tabor and Wight 1977, Toweill 1974

Common name	Scientific name	References
Family Felidae		
cougar	*Felis concolor*	Hornocker 1970, Seidensticker et al. 1973, Sitton 1977
bobcat	*Lynx rufus*	Crowe 1975, Gashwiler et al. 1961, Sweeney 1977
ORDER ARTIODACTYLA		
Family Cervidae		
mule deer	*Odocoileus hemionus*	Dealy 1970
Family Antilocapridae		
pronghorn	*Antilocapra americana*	Autenrieth and Fichter 1975, Kitchen 1974, Sundstrom et al. 1973, Yoakum 1967
Family Bovidae		
bighorn sheep	*Ovis canadensis*	Berger 1978, McGlinchy et al. 1971, Spalding and Mitchell 1970

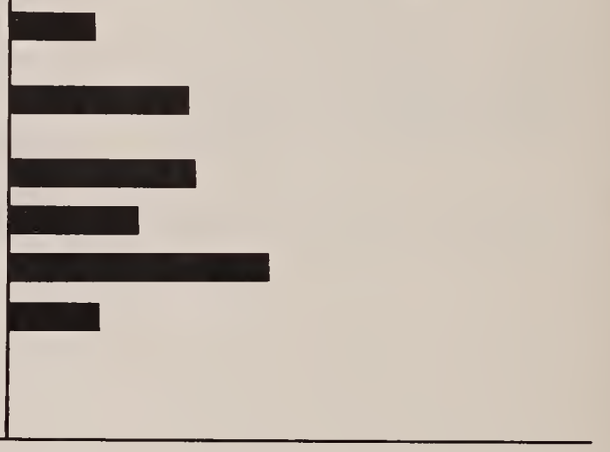
Appendix 11. Species versatility ratings by life form. Life form 1: reproduces in water; feeds in water. (2 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	AMPHIBIANS							
RAPR	spotted frog	1	5	6	1	5	6	12
RACA	bullfrog	1	5	6	1	5	6	12
						Total		24
						$\overline{X}$ =		12



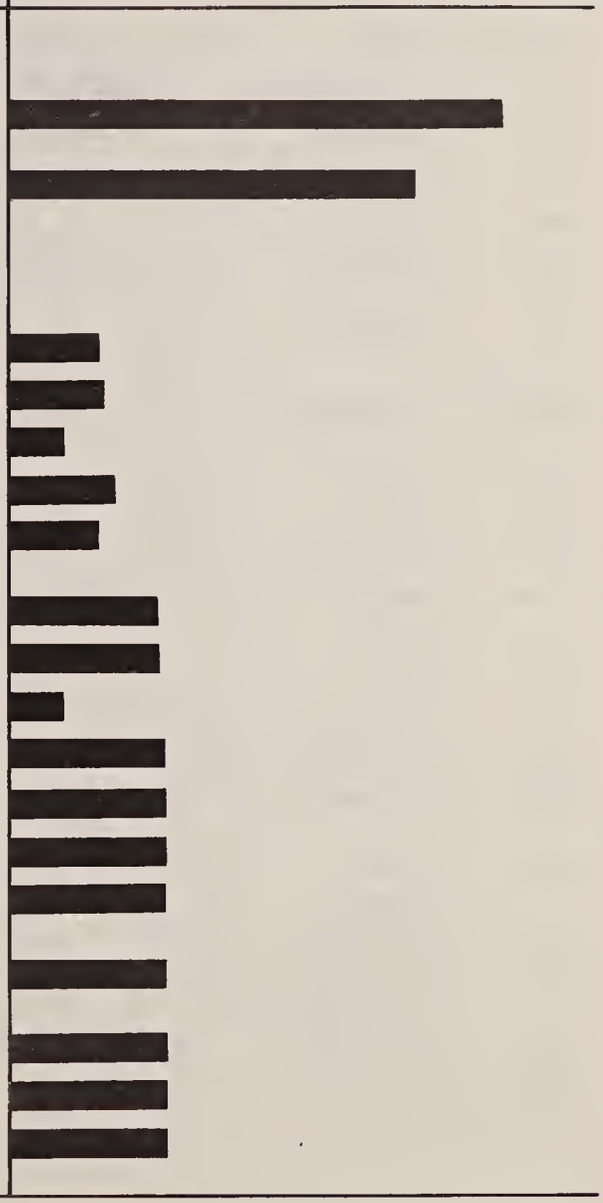
Appendix 11. Life form 2: reproduces in water; feeds on ground, in shrubs, and/or in trees. (6 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	AMPHIBIANS							
AMMA	long-toed salamander	2	4	6	2	3	5	11
SCIN	Great Basin spadefoot toad	2	4	6	7	10	17	23
BUBO	western toad	2	5	7	8	8	16	23
BUWO	Woodhouse toad	1	4	5	5	6	11	16
HYRE	Pacific treefrog	3	9	12	6	13	19	31
RAPI	leopard frog	1	3	4	1	6	7	11
							Total	115
							$\overline{X}$ =	19.2

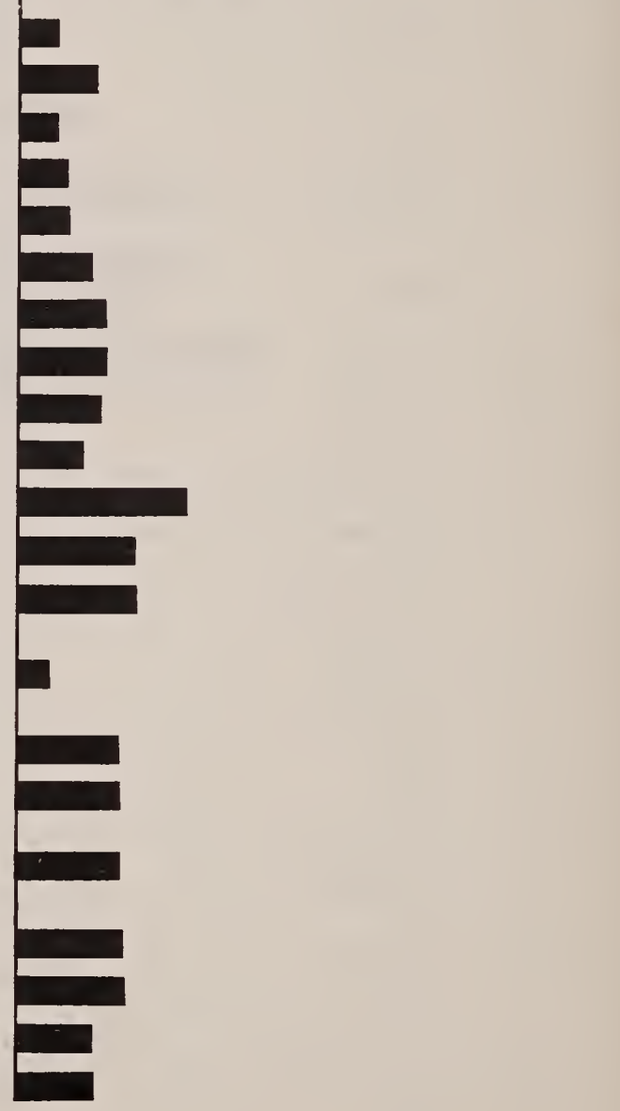


Appendix 11. Life form 3: reproduces on ground around water, or on floating, or emergent vegetation; feeds in water, on ground, in shrubs, and trees. (44 species)

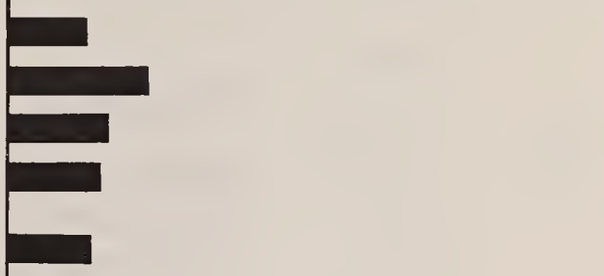
Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	REPTILES							
THST	common garter snake	12	15	27	14	15	29	56
THEL	wandering garter snake	7	15	22	9	15	24	46
	BIRDS							
POAU	horned grebe	1	3	4	1	5	6	10
PONIGR	eared grebe	1	3	4	1	5	6	10
AEOC	western grebe	1	4	5	1	0	1	6
POPO	pied-billed grebe	1	5	6	1	5	6	12
PHAU	double-crested cormorant	2	6	8	1	0	1	9
BOLE	American bittern	1	5	6	1	10	11	17
IXEX	least bittern	1	5	6	1	10	11	17
BRCA	Canada goose	1	2	3	1	2	3	6
ANPL	mallard	1	7	8	2	8	10	18
ANSTR	gadwall	1	7	8	2	8	10	18
ANAC	common pintail	1	7	8	2	8	10	18
ANCR	green-winged teal	1	7	8	2	8	10	18
ANDIS	blue-winged teal	1	7	8	2	8	10	18
ANCY	cinnamon teal	1	7	8	2	8	10	18
ANAMEO	American wigeon	1	7	8	2	8	10	18
ANCL	northern shoveler	1	7	8	2	8	10	18



Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
AYAM	redhead	1	1	2	1	1	2	4
AYCO	ring-necked duck	1	2	3	2	3	5	8
AYVA	canvasback	1	1	2	1	1	2	4
AYAF	lesser scaup	1	1	2	1	2	3	5
OXJA	ruddy duck	1	1	2	1	2	3	5
GRCA	sandhill crane	2	1	3	3	2	5	8
RALI	Virginia rail	1	3	4	2	4	6	10
POCAR	sora	1	3	4	2	4	6	10
FUAM	American coot	1	3	4	1	4	5	9
CHALE	snowy plover	0	1	1	3	2	5	6
CHVO	killdeer	3	6	9	3	6	9	18
CAGA	common snipe	3	3	6	3	4	7	13
ACMA	spotted sandpiper	1	4	5	1	7	8	13
TRME	greater yellowlegs	1	1	2	1	1	2	4
REAM	American avocet	3	1	4	3	4	7	11
HIME	black-necked stilt	1	3	4	1	6	7	11
STTRI	Wilson's phalarope	1	3	4	1	6	7	11
LACA	California gull	1	2	3	3	5	8	11
LAPI	Franklin's gull	1	2	3	3	5	8	11
STFO	Forster's tern	1	2	3	1	5	6	9
STCAS	Caspian tern	1	2	3	1	5	6	9

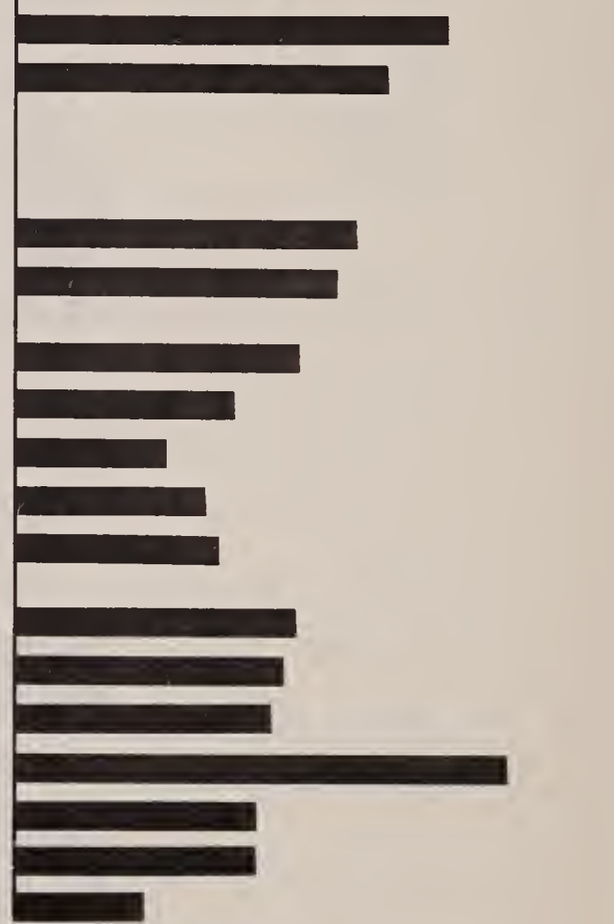


Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
CHNI	black tern	1	2	3	1	5	6	9
CIME	dipper	1	5	6	1	9	10	16
CIPA	marsh wren	1	5	6	1	5	6	12
GETR	common yellowthroat	1	2	3	1	7	8	11
XAXA	yellow-headed blackbird	1	4	5	1	4	5	10
							Total	581
							$\overline{X}$ =	13.20

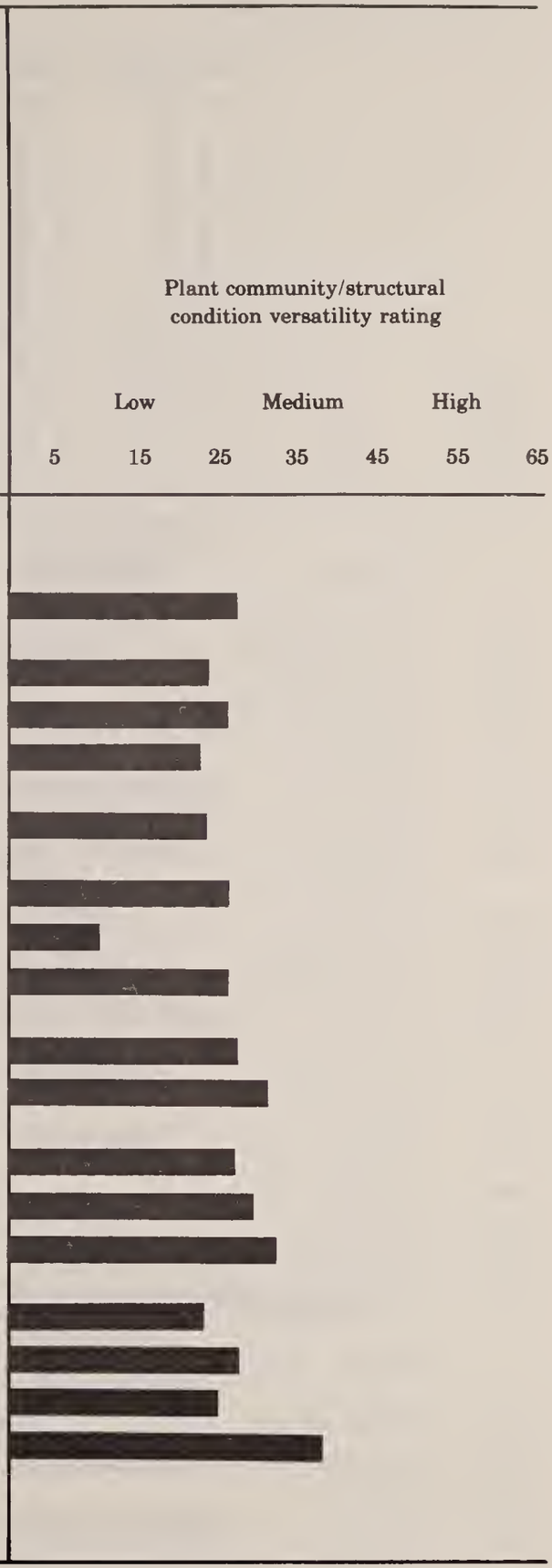


Appendix 11. Life form 4: reproduces in cliffs, caves, rims, and/or talus; feeds on ground or in air. (33 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	REPTILES							
CRCO	collared lizard	9	15	24	9	15	24	48
SCOC	western fence lizard	6	15	21	6	15	21	42
	BIRDS							
CAAU	turkey vulture	3	5	8	15	15	30	38
BUREG	ferruginous hawk	7	9	16	10	10	20	36
FAME	prairie falcon	2	10	12	10	10	20	32
ALCH	chukar	3	3	6	9	10	19	25
COLI	rock dove	3	4	7	2	8	10	17
CYNI	black swift	2	5	7	5	10	15	22
AESA	white-throated swift	3	5	8	5	10	15	23
SASA	Say's phoebe	6	5	11	10	10	20	31
HIRU	barn swallow	4	5	9	11	10	21	30
PEPY	cliff swallow	2	5	7	11	10	21	28
COCOR	common raven	15	10	25	15	15	30	55
CAMEXO	canyon wren	3	10	13	4	10	14	27
SAOB	rock wren	3	10	13	4	10	14	27
LEAT	black rosy finch	1	3	4	1	10	11	15

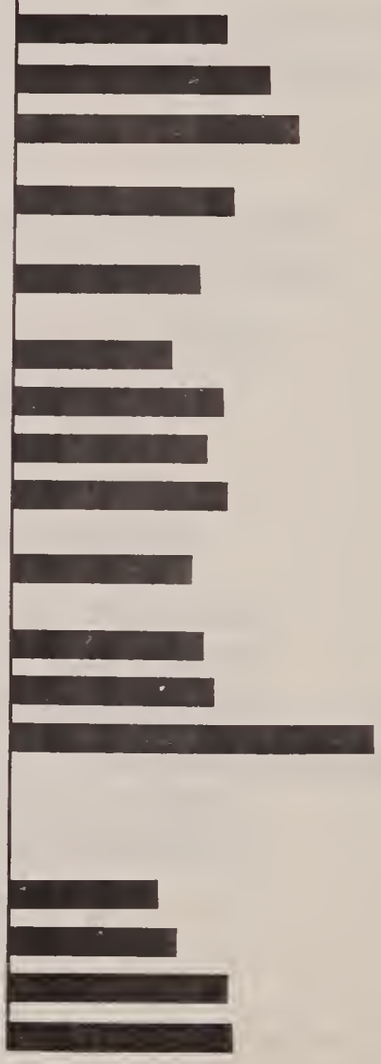


Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	MAMMALS							
MYLU	little brown myotis	3	10	13	3	12	15	28
MYTH	fringed myotis	2	10	12	2	11	13	25
MYCA	California myotis	3	10	13	3	11	14	27
MYLE	small-footed myotis	2	10	12	2	10	12	24
PIHE	western pipistrelle	2	10	12	2	11	13	25
EPFU	big brown bat	3	10	13	3	11	14	27
EUMAC	spotted bat	2	4	6	2	4	6	12
PLTO	western big-eared bat	2	10	12	2	13	15	27
ANPA	pallid bat	3	10	13	3	12	15	28
MAFL	yellow-bellied marmot	12	4	16	12	4	16	32
PECR	canyon mouse	3	11	14	3	11	14	28
NELE	desert woodrat	4	11	15	4	11	15	30
NECI	bushy-tailed woodrat	2	11	13	9	11	20	33
ERDO	porcupine	6	4	10	6	8	14	24
SPPU	spotted skunk	3	10	13	3	12	15	28
FECO	cougar	5	6	11	9	6	15	26
LYRU	bobcat	12	6	18	15	6	21	39
						Total		959
						$\overline{X}$ =		29.0

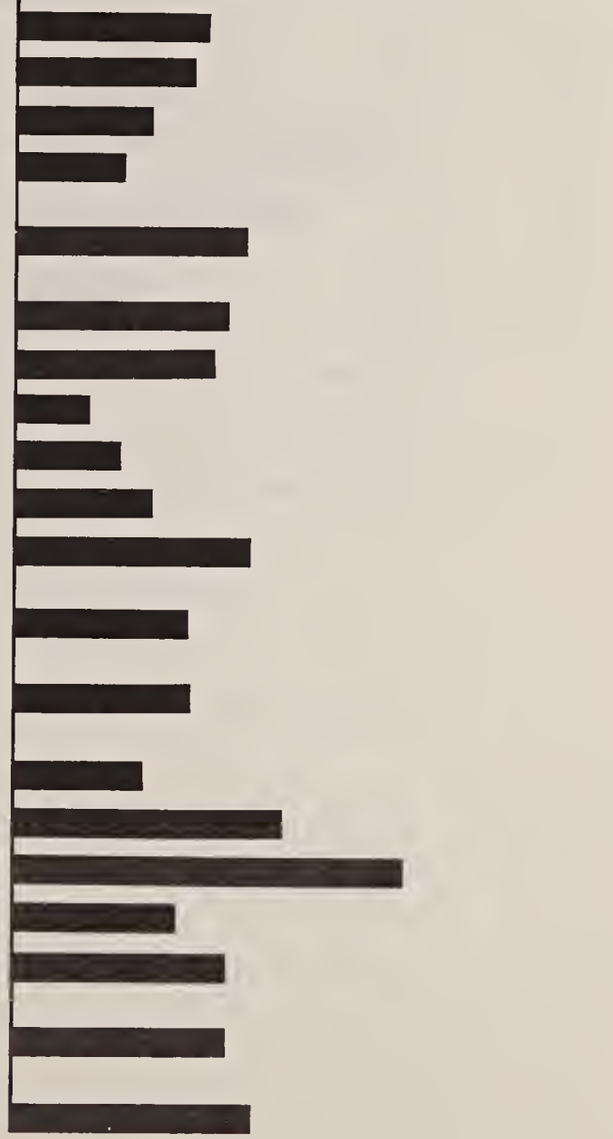


Appendix 11. Life form 5: reproduces on ground without specific water, cliff, rim, or talus association; feeds on ground. (45 species)

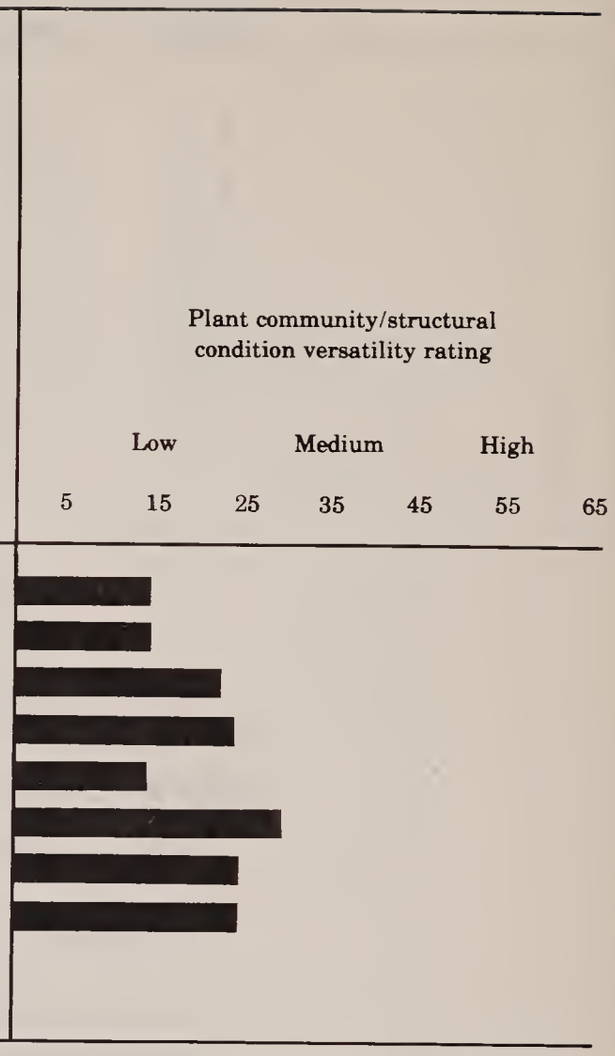
Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	REPTILES							
CRWI	leopard lizard	4	8	12	4	8	12	24
SCGR	sagebrush lizard	5	8	13	5	10	15	28
UTST	side-blotched lizard	5	8	13	5	14	19	32
PHPL	desert horned lizard	5	7	12	5	8	13	25
PHDO	short-horned lizard	3	7	10	3	8	11	21
EUSK	western skink	3	4	7	3	8	11	18
CNTI	western whiptail	6	6	12	6	6	12	24
CHBO	rubber boa	2	8	10	2	10	12	22
COCONS	yellow-bellied racer	4	8	12	4	8	12	24
MATA	striped whipsnake	1	8	9	1	10	11	20
PIME	gopher snake	5	4	9	5	7	12	21
HYTO	night snake	4	5	9	4	10	14	23
CRVI	western rattlesnake	13	5	18	13	10	23	41
	BIRDS							
CICY	northern harrier	4	3	7	5	5	10	17
DEOB	blue grouse	5	3	8	5	6	11	19
BOUM	ruffed grouse	5	4	9	8	8	16	25
CEUR	sage grouse	2	8	10	8	8	16	26



Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
LOCA	California quail	8	3	11	8	3	11	22
ORPI	mountain quail	2	4	6	6	8	14	20
PEPER	gray partridge	3	2	5	5	6	11	16
PHCOL	ring-necked pheasant	2	4	6	2	4	6	12
NUAM	long-billed curlew	4	6	10	6	10	16	26
ASFL	short-eared owl	4	2	6	8	10	18	24
ERAL	horned lark	2	5	7	6	10	16	23
CAFU	veery	1	3	4	1	3	4	8
WIPU	Wilson's warbler	3	3	6	3	3	6	12
DOOR	bobolink	3	5	8	3	5	8	16
STNEG	western meadowlark	6	2	8	9	10	19	27
PASA	savannah sparrow	1	4	5	4	10	14	19
AMSA	grasshopper sparrow	1	4	5	4	10	14	19
POGRA	vesper sparrow	1	4	5	4	6	10	15
CHGR	lark sparrow	5	4	9	11	10	21	30
JUHY	northern junco	12	8	20	14	10	24	44
SYID	pygmy rabbit	5	4	9	5	4	9	18
SYNU	mountain cottontail	8	4	12	8	4	12	24
LETO	white-tailed jackrabbit	1	5	6	9	9	18	24
LECA	black-tailed jackrabbit	2	4	6	13	8	21	27

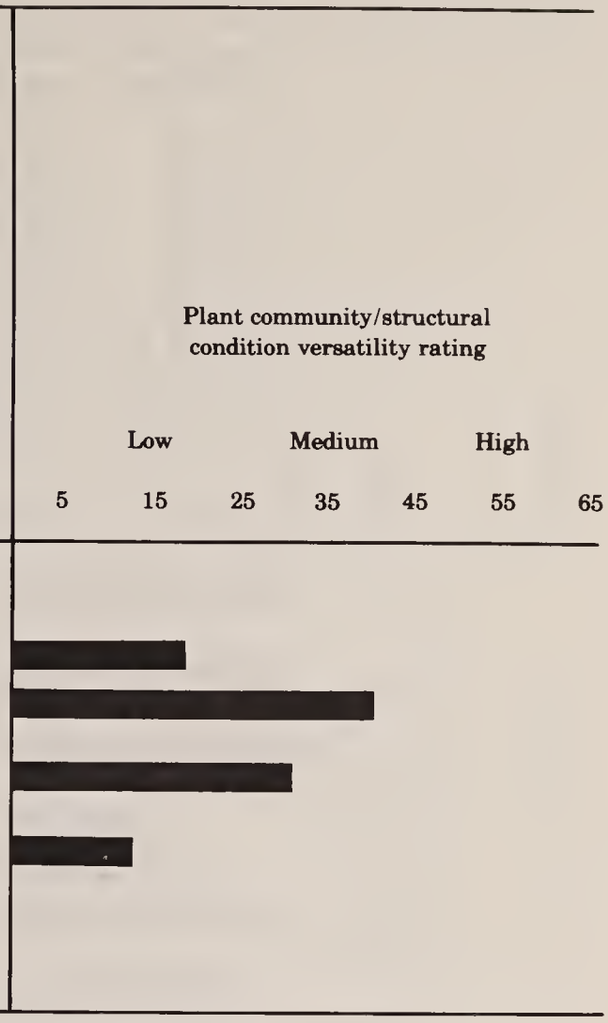


Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
RARA	black rat	4	4	8	4	4	8	16
RANO	Norway rat	4	4	8	4	4	8	16
FECA	feral house cat	3	4	7	5	10	15	22
EQUA	feral horse	4	8	12	5	8	13	25
CEEL	elk	3	2	5	7	4	11	16
ODHE	mule deer	5	2	7	14	9	23	30
ANAMER	pronghorn	2	3	5	10	10	20	25
OVCA	bighorn sheep	3	3	6	10	9	19	25
							Total	101
							$\overline{X}$ =	22.5



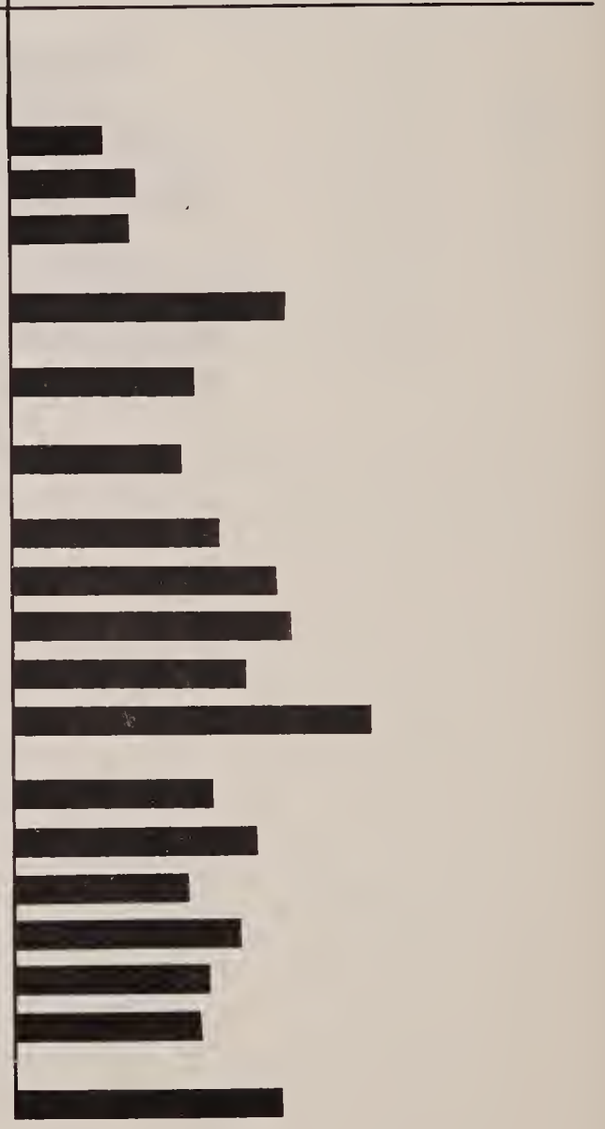
Appendix 11. Life form 6: reproduces on ground; feeds in shrubs, trees, or air. (4 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
PHNU	poorwill	2	2	4	8	8	16	20
CHMI	common nighthawk	5	8	13	14	14	28	41
MYTO	Townsend's solitaire	4	8	12	12	8	20	32
VECE	orange-crowned warbler	3	4	7	3	4	7	14
						Total		107
						$\overline{X}$ =		26.8

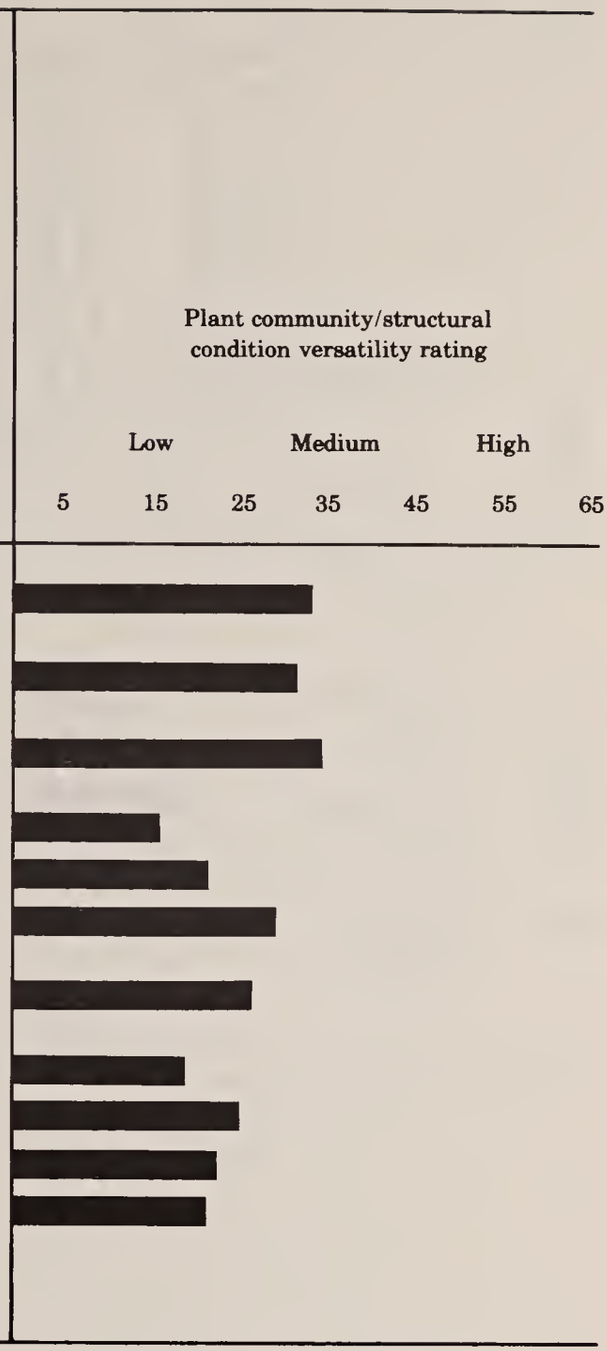


Appendix 11. Life form 7: reproduces in shrubs; feeds on ground, in water or air. (29 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
BUST	green heron	1	3	4	1	4	5	9
BUIB	cattle egret	3	3	6	5	4	9	15
NYNY	black-crowned night heron	3	3	6	5	3	8	14
BUSW	Swainson's hawk	5	6	11	10	10	20	31
STCAL	calliope hummingbird	5	3	8	7	5	12	20
CAAN	Anna's hummingbird	5	3	8	7	4	11	19
TYTY	eastern kingbird	6	3	9	8	7	15	24
EMTR	willow flycatcher	3	6	9	12	8	20	29
EMWR	gray flycatcher	7	6	13	12	6	18	31
APCO	scrub jay	6	4	10	10	6	16	26
PIPI	black-billed magpie	9	6	15	15	10	25	40
DUCA	gray catbird	3	4	7	9	6	15	22
TORV	brown thrasher	6	4	10	11	6	17	27
ORMO	sage thrasher	4	4	8	7	4	11	19
TUMI	American robin	3	6	9	9	8	17	26
CAUS	Swainson's thrush	4	4	8	8	6	14	22
PACAE	blue-gray gnatcatcher	3	6	9	6	6	12	21
LALU	loggerhead shrike	5	5	10	12	8	20	30

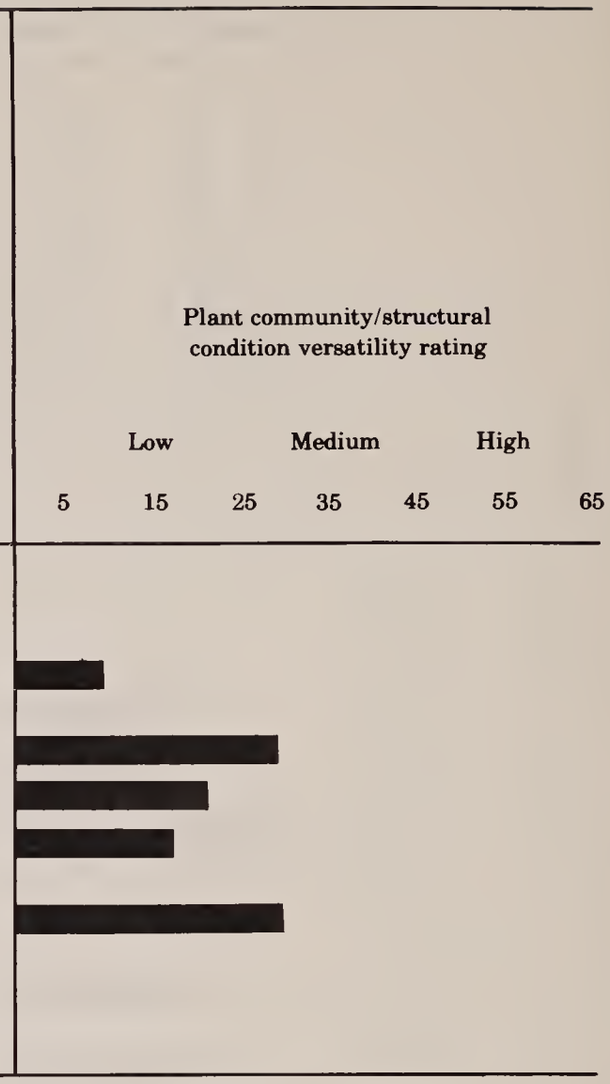


Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
AGPH	red-winged blackbird	6	5	11	14	8	22	33
EUCY	Brewer's blackbird	7	15	12	14	5	19	31
MOAT	brown-headed cowbird	7	7	14	14	7	21	35
PAAMO	lazuli bunting	3	4	7	4	6	10	17
CAPS	lesser goldfinch	4	2	6	8	8	16	22
PICH	green-tailed towhee	6	6	12	11	6	7	29
PIER	rufous-sided towhee	6	6	12	9	6	15	27
AMBE	sage sparrow	5	4	9	5	6	11	20
SPPA	chipping sparrow	5	6	11	9	6	15	26
SPBRE	Brewer's sparrow	4	6	10	5	8	13	23
NEMEL	song sparrow	4	4	8	11	4	14	22
						Total		710
						$\overline{X}$ =		24.5



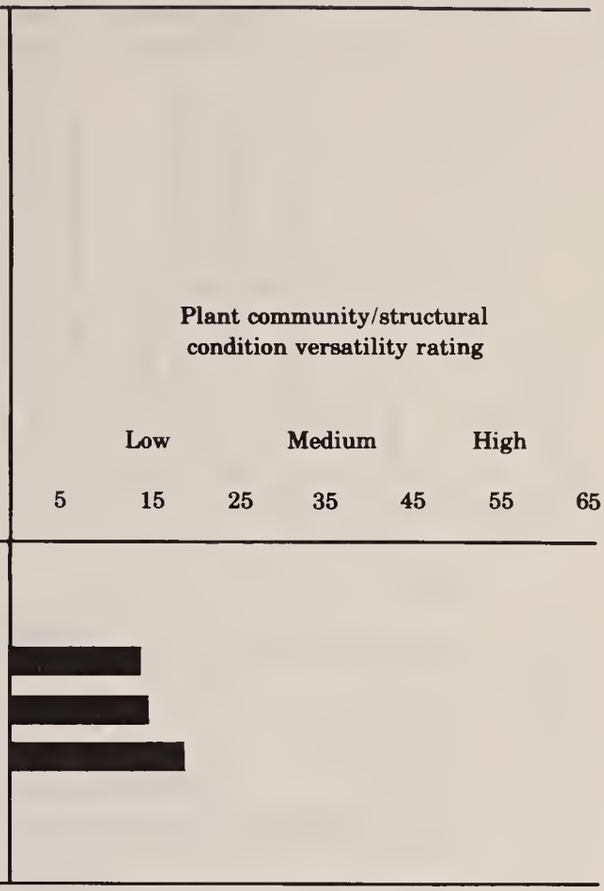
Appendix 11. Life form 8: reproduces in shrubs; feeds in shrubs, trees, or air. (5 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
COAM	yellow-billed cuckoo	1	4	5	1	4	5	10
PSMI	bushtit	5	4	9	12	8	20	29
DEPE	yellow warbler	2	6	8	8	6	14	22
ICVI	yellow-breasted chat	3	4	7	7	4	11	18
CATR	American goldfinch	4	6	10	9	8	17	27
						Total		106
						$\overline{X}$ =		21.2



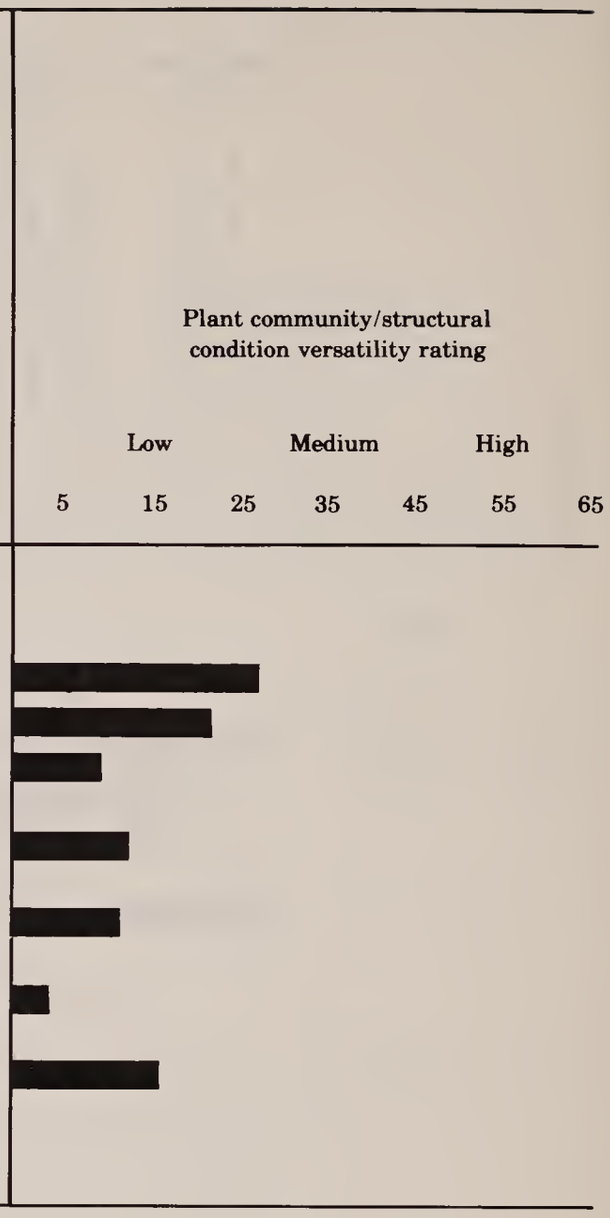
Appendix 11. Life form 9: reproduces primarily in deciduous trees; feeds in shrubs, trees, or air. (3 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
BOCE	cedar waxwing	3	3	6	5	5	10	16
ICGA	northern oriole	3	4	7	4	6	10	17
CAMEXI	house finch	5	2	7	9	4	13	20
						Total		53
						$\overline{X}$ =		17.7



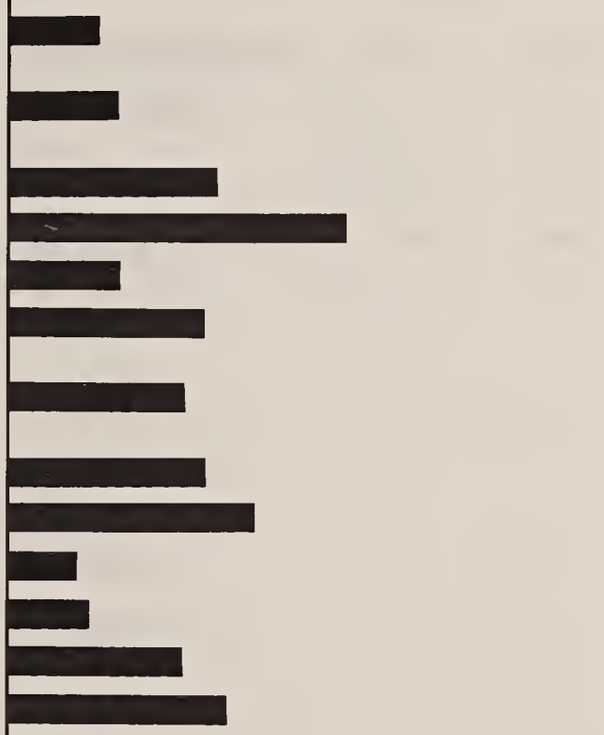
Appendix 11. Life form 10: reproduces primarily in conifers; feeds in shrubs, trees, or air. (7 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
EMDI	western flycatcher	4	6	10	9	8	17	27
GYCY	pinyon jay	1	6	7	9	6	15	22
RECA	ruby-crowned kinglet	3	2	5	3	2	5	10
DECOR	yellow-rumped warbler	4	2	6	5	2	7	13
DENI	black-throated gray warbler	1	2	3	5	4	9	12
DETO	Townsend's warbler	1	1	2	1	1	2	4
PILU	western tanager	3	2	5	4	8	12	17
						Total		105
						$\overline{X}$ =		15.0



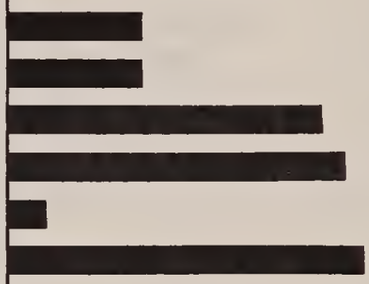
Appendix 11. Life form 11: reproduces in trees; feeds on ground, in shrubs, trees, or air. (13 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
ACGE	northern goshawk	2	2	4	3	4	7	11
ACST	sharp-shinned hawk	3	2	5	4	4	8	13
ACCO	Cooper's hawk	3	4	7	8	8	16	23
ZEMA	mourning dove	10	8	18	15	5	20	38
ASOT	long-eared owl	3	3	6	4	3	7	13
TYVE	western kingbird	4	4	8	9	5	14	22
COSO	western wood pewee	3	3	6	9	5	14	20
CYST	Steller's jay	5	3	8	9	5	14	22
COBRA	American crow	5	4	9	14	5	19	28
VIOL	red-eyed vireo	3	1	4	3	1	4	8
VIGI	warbling vireo	3	2	5	3	2	5	10
CAPU	purple finch	4	2	6	11	3	14	20
SPARB	American tree sparrow	4	2	6	11	8	19	25
						Total		253
						$\overline{X}$ =		19.5



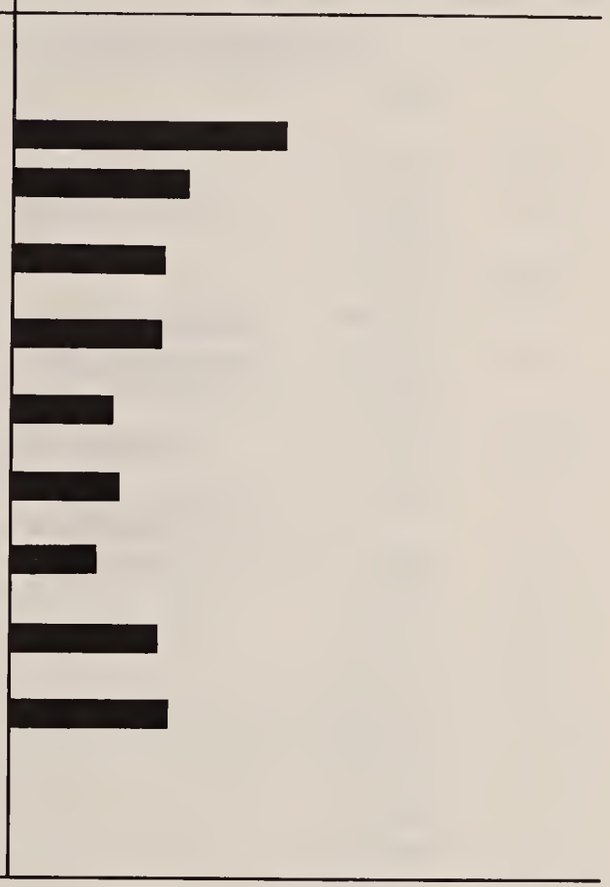
Appendix 11. Life form 12: reproduces on very thick branches; feeds on ground or in water. (6 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
ARHE	great blue heron	4	7	11	3	1	4	15
CAAL	common egret	4	7	11	3	1	4	15
BUJA	red-tailed hawk	6	6	12	14	10	24	36
AQCH	golden eagle	7	6	13	15	10	25	38
PAHA	osprey	1	2	3	1	0	1	4
BUVIR	great horned owl	9	6	15	15	10	25	40
						Total		148
						$\overline{X}$ =		24.7



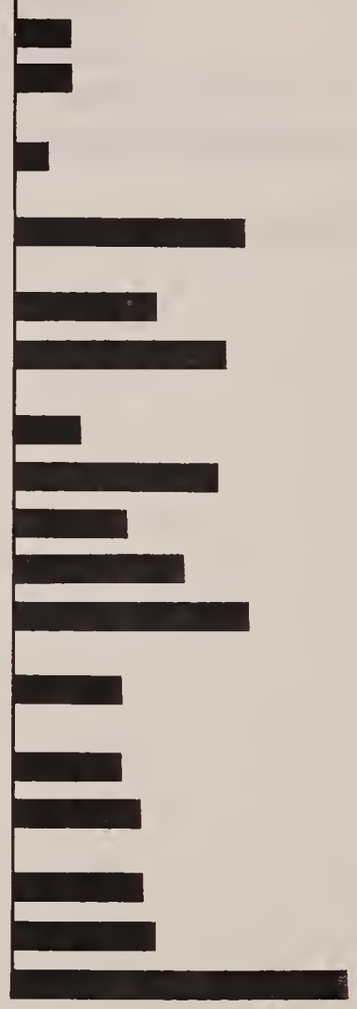
Appendix 11. Life form 13: reproduces – excavates own hole in a tree; feeds on ground, in shrubs, trees, or air. (9 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
COAU	common flicker	4	6	10	12	9	21	31
MELE	Lewis' woodpecker	3	6	9	3	8	11	20
SPVAR	yellow-bellied sapsucker	4	4	8	4	5	9	17
SPTH	Williamson's sapsucker	4	4	8	4	5	9	17
PIVI	hairy woodpecker	4	2	6	4	2	6	12
PIPU	downy woodpecker	3	3	6	3	4	7	13
PIAL	white-headed woodpecker	1	3	4	3	3	6	10
SICAR	white-breasted nuthatch	1	6	7	4	6	10	17
SICAN	red-breasted nuthatch	2	6	8	4	6	10	18
							Total	155
							$\overline{X}$ =	17.2

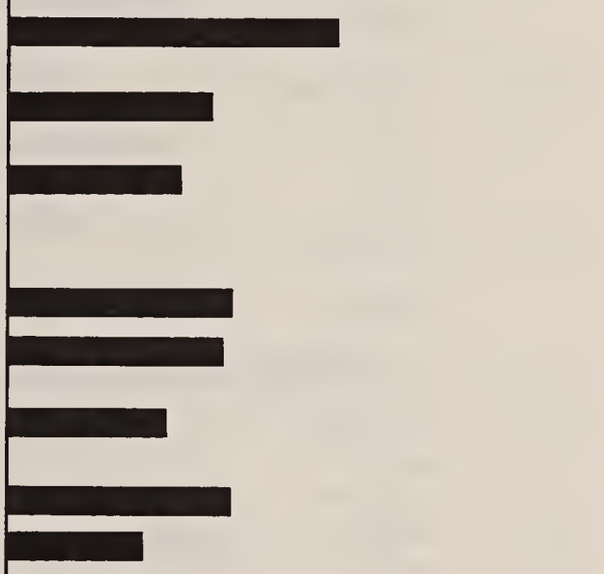


Appendix 11. Life form 14: reproduces in a hole made by another species or that has occurred naturally; feeds on ground, in water, or air. (25 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
AISP	wood duck	1	4	5	1	0	1	6
BUIS	Barrow's goldeneye	1	4	5	1	0	1	6
MEMER	common merganser	1	1	2	1	1	2	4
FASP	American kestrel	5	5	10	8	8	16	26
TYAL	barn owl	2	4	6	5	6	11	17
OTAS	common screech owl	5	4	9	9	6	15	24
OTFL	flammulated owl	2	2	4	2	2	4	8
GLGN	pygmy owl	4	4	8	9	6	15	23
AEAC	saw-whet owl	3	3	6	3	4	7	13
CHVA	Vaux's swift	1	4	5	6	9	15	20
MYCI	ash-throated flycatcher	5	4	9	10	8	18	27
TATH	violet-green swallow	3	2	5	5	3	8	13
IRBI	tree swallow	3	2	5	5	3	8	13
PAATR	black-capped chickadee	4	2	6	6	3	9	15
CEFA	brown creeper	4	2	6	6	3	9	15
TRAE	house wren	6	2	8	6	3	9	17
SIME	western bluebird	6	6	12	14	12	26	38

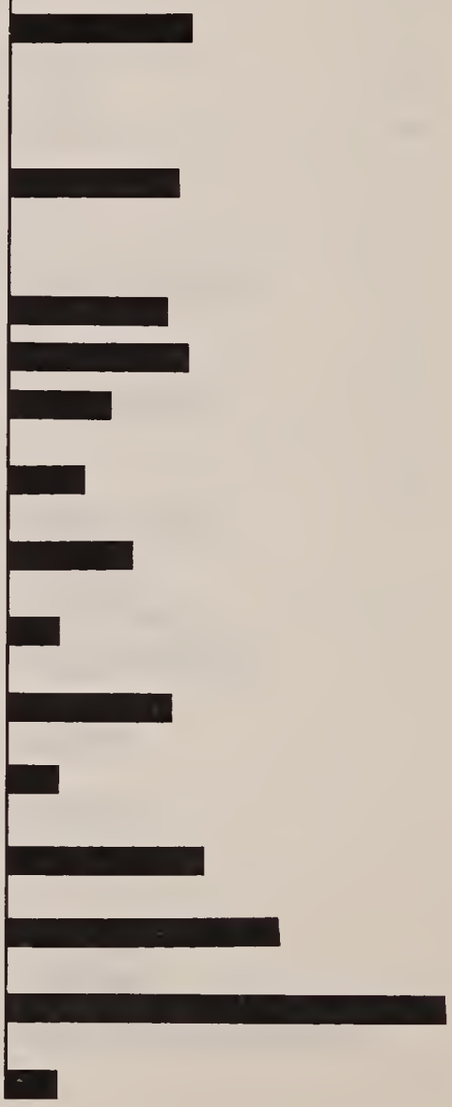


Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
SICU	mountain bluebird	6	6	12	14	12	26	38
STVU	European starling	5	2	7	8	8	16	23
PADO	house sparrow	4	2	6	6	8	14	20
	MAMMALS							
MYYU	Yuma myotis	1	6	7	10	8	18	25
MYEV	long-eared myotis	0	6	6	10	8	18	24
MYVO	long-legged myotis	0	3	3	10	5	15	18
LANO	silver-haired bat	1	6	7	10	8	18	25
PRLO	raccoon	1	4	5	1	9	10	15
						Total		463
						$\overline{X}$ =		18.5

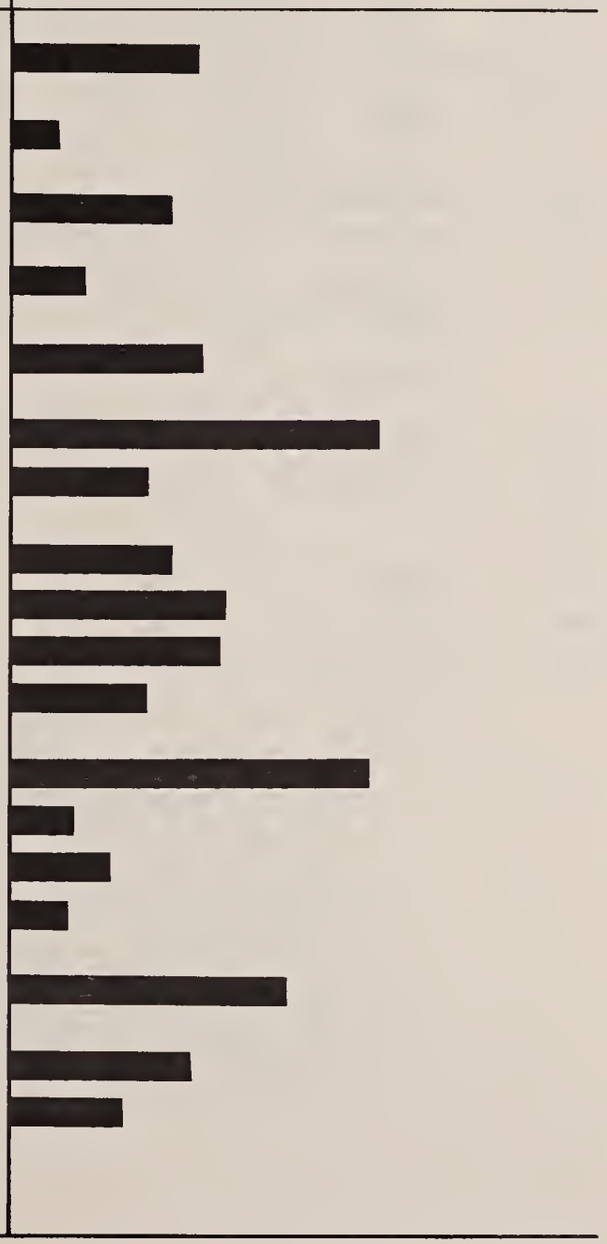


Appendix 11. Life form 15: reproduces underground in burrow; feeds on or under ground. (32 species)

Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	REPTILES							
SOSE	western ground snake	4	4	8	4	8	12	20
	BIRDS							
ATCU	burrowing owl	3	4	7	8	4	12	19
	MAMMALS							
SOME	Merriam shrew	3	5	8	3	5	8	16
EUMI	least chipmunk	6	3	9	6	5	11	20
EUQM	yellow pine chipmunk	2	4	6	2	4	6	12
AMLE	antelope ground squirrel	2	2	4	2	2	4	8
SPTO	Townsend ground squirrel	3	4	7	3	4	7	14
SPRI	Richardson ground squirrel	1	2	3	1	2	3	6
SPBE	Belding ground squirrel	5	4	9	5	4	9	18
SPCO	Columbian ground squirrel	1	2	3	1	2	3	6
SPLA	mantled ground squirrel	6	4	10	6	6	12	22
THTO	Townsend pocket gopher	7	8	15	7	8	15	30
THTA	northern pocket gopher	15	10	25	15	10	25	50
PELO	little pocket mouse	1	2	3	1	2	3	6

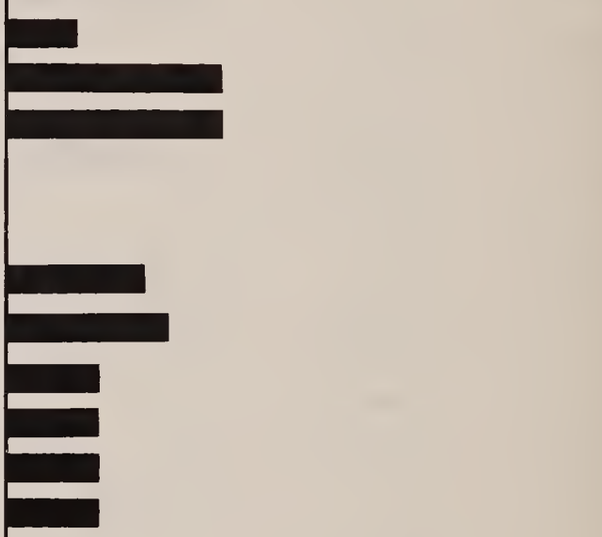


Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
PEPA	Great Basin pocket mouse	5	6	11	5	6	11	22
MIME	dark kangaroo mouse	1	2	3	1	2	3	6
DIOR	Ord kangaroo rat	3	6	9	3	6	9	18
DIMI	chisel-toothed kangaroo rat	2	2	4	2	2	4	8
REME	western harvest mouse	5	6	11	5	6	11	22
PEMA	deer mouse	15	6	21	15	6	21	42
ONLE	northern grass-hopper mouse	2	6	8	2	6	8	16
MIMO	montane vole	4	5	9	4	5	9	18
MILO	long-tailed vole	6	6	12	6	6	12	24
LACU	sage vole	4	6	10	4	9	13	23
ZAPR	western jumping mouse	3	5	8	3	5	8	16
CALAT	coyote	13	6	19	14	8	22	41
VUVU	red fox	1	2	3	1	3	4	7
VUMA	kit fox	3	2	5	3	4	7	12
MUER	short-tailed weasel	1	2	3	1	3	4	7
MUFR	long-tailed weasel	9	6	15	9	7	16	31
TATA	badger	4	6	10	4	6	10	20
MEMEP	striped skunk	2	3	5	2	6	8	13
						Total		593
						$\overline{X}$ =		18.5



Appendix 11. Life form 16: reproduces underground in burrow; feeds in water, on ground, or in air. (9 species)

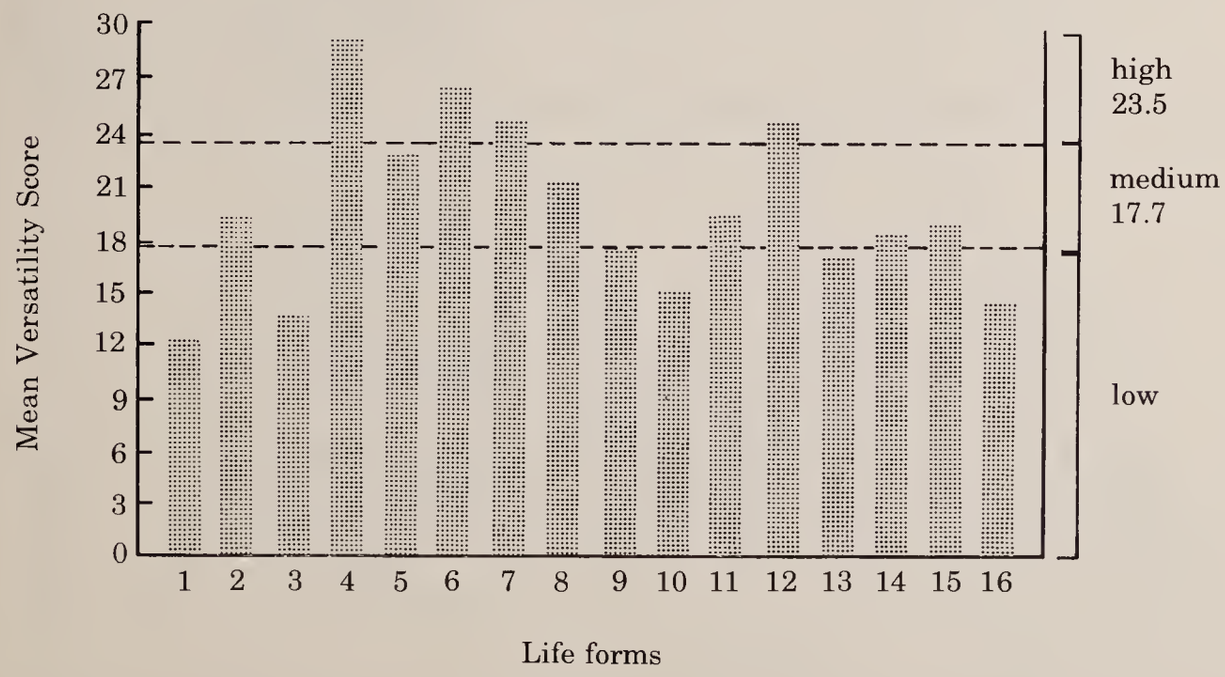
Letter code	Species	Reproductive orientation: No. of plant communities used (1)	Reproductive orientation: No. of structural conditions used (2)	Reproductive orientation: Columns 1 & 2 (3)	Feeding orientation: No. of plant communities used (4)	Feeding orientation: No. of structural conditions used (5)	Feeding orientation: Columns 4 & 5 (6)	Versatility score columns 3 & 6 (7)
	BIRDS							
MEAL	belted kingfisher	1	6	7	1	0	1	8
RIRI	bank swallow	1	8	9	6	9	15	24
STRU	rough-winged swallow	1	8	9	6	9	15	24
	MAMMALS							
SOPR	Malheur shrew	3	5	8	3	5	8	16
SOVA	wandering shrew	4	5	9	4	5	9	18
CACAN	beaver	1	4	5	1	4	5	10
ONZI	muskrat	1	4	5	1	4	5	10
MUVI	mink	1	4	5	1	4	5	10
LUCA	river otter	1	4	5	1	4	5	10
						Total		130
						$\overline{X}$ =		14.4



Appendix 12. Life form versatility rating summary.

Life form[1]	Number of species[2]	Range of versatility scores	Mean versatility score	Life form[3] versatility rating (median scale)	Life form[1]	Number of species[2]	Range of versatility scores	Mean versatility score	Life form[3] versatility rating (median scale)
1	2	12	12	low	10	10	4-27	15.0	low
2	6	11-31	19.2	medium	11	13	8-38	19.5	medium
3	44	4-56	13.2	low	12	6	4-40	24.7	high
4	33	12-55	29.0	high	13	9	10-31	17.2	low
5	45	8-44	22.5	medium	14	25	4-38	18.5	medium
6	4	14-41	26.8	high	15	32	6-50	18.5	medium
7	29	9-40	24.5	high	16	9	8-24	14.4	low
8	5	10-29	21.2	medium					
9	3	16-20	17.7	medium	Total: 275				
					$\overline{X}$ = 19.8				

[1] See table 1 for life form descriptions.
[2] Refers to total number of species in life form.
[3] "Low" = 12.0-17.6, " medium" = 17.7-23.4, "high" = 23.5-29.0.



Appendix 13. 110 wildlife species in southeast Oregon of "special interest"

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Appendix 13. Continued

		Species	1	2	3	4	5	6	7[1]	8[1]
		AMPHIBIANS								
RAPR	1	spotted frog[2]					X			
		REPTILES								
CRCO	4	collared lizard					X			
CRWI	5	leopard lizard					X			
PHDO	5	short-horned lizard					X			
CNTI	5	western whiptail				SI				
HYTO	5	night snake				SI				
CRVI	5	western rattlesnake				SI	X			
		BIRDS								
POGRI	3	red-necked grebe*				SI	P	X		
AEOC	3	western grebe						X		
PEER	3	American white pelican*					R	X		
PHAU	3	double-crested cormorant						X		
NYNY	7	black-crowned night heron						X		
BOLE	3	American bittern				SI		X		
PLCH	7	white-faced ibis*			SU	SI	P	X		
BRCA	3	Canada goose[3]		E		SI	E			
ANAL	3	white-fronted goose[4]*					E			
AYCO	3	ring-necked duck					P			
AYVA	3	canvasback						X		
AYAF	3	lesser scaup					P			
BUIS	14	Barrow's goldeneye					P			
BUALBE	14	bufflehead					P			

Letter code	Life form		1	2	3	4	5	6	7	8
		E – Endangered	Federal Register (endangered)	Oregon State (endangered or threatened)	U.S. Dep. Inter. Fish & Wildl. Serv. "Red Book"	USDA FS RNA "Yellow Book"	OSU endangered plants and animals of Oregon	Audubon – Blue list for 1979		
		P – Peripheral								
		R – Rare								
		SI – Species of special interest								
		SU – Status undetermined								
		T – Threatened								
		U – Unique								
		X – Occurs on list	1	2	3	4	5	6	7	8
				(a & b)			(a)			

NOTE: See footnotes at end of appendix 13, p. 207.

Appendix 13. Continued

Letter code	Life form	Species	1	2	3	4	5	6	7	8
CAAU	4	turkey vulture				SI				
ACST	11	sharp-shinned hawk						X		
ACCO	11	Cooper's hawk						X		
BUJA	12	red-tailed hawk[5]				SI				
BUSW	7	Swainson's hawk					R	X		
BULA	4	rough-legged hawk				SI				
BUREG	4	ferruginous hawk				SI	E	X		
AQCH	12	golden eagle				SI				
HALE	12	bald eagle*	T	T		SI	E			
CICY	5	northern harrier						X		
PAHA	12	osprey			SU	SI	R	X		
FAME	4	prairie falcon			T	SI	R	X		
FAPE	4	peregrine*	E	E	T	SI	E			
FACO	11	merlin*				SI	E	X		
FASP	14	American kestrel[6]				SI		X		
CEUR	5	sage grouse						X		
GRCA	3	sandhill crane				SI	E			
RALI	3	Virginia rail				SI				
CHALE	3	snowy plover		T		SI	R	X		
CHMO	3	mountain plover*				SI				
NUAM	3	long-billed curlew			SU	SI				
TRSO	7	solitary sandpiper*				SI				
CASE	3	willet*				SI				
CABA	3	Baird's sandpiper*				SI				
LAPI	3	Franklin's gull				SI	SU			
STCAS	3	Caspian tern				SI	SU			
CHNI	3	black tern						X		
COAM	8	yellow-billed cuckoo				SI	SU	X		
TYAL	14	barn owl						X		
OTAS	14	common screech owl				SI	SU			
		Federal Register (endangered)								
		Oregon State (endangered or threatened)								
		U.S. Dep. Inter. Fish & Wildl. Serv. "Red Book"								
		USDA FS RNA "Yellow Book"								
		OSU endangered plants and animals of Oregon								
		Audubon – Blue list for 1979								
		1	2	3	4	5	6	7	8
			(a & b)			(a)				

E – Endangered
P – Peripheral
R – Rare
SI – Species of special interest
SU – Status undetermined
T – Threatened
U – Unique
X – Occurs on list

Appendix 13. Continued

Species			1	2	3	4	5	6	7	8
OTFL	14	flammulated owl				SI	SU			
ATCU	15	burrowing owl			SU	SI		X		
ASFL	5	short-eared owl						X		
PHNU	6	poorwill				SI	SU			
CHMI	6	common nighthawk						X		
PILE	13	Lewis' woodpecker						X		
PIVI	13	hairy woodpecker						X		
SICAN	13	red-breasted nuthatch				SI				
MIPO	7	northern mockingbird				SI	P			
DUCA	7	gray catbird				SI	P			
CAGN	5	hermit thrush				SI				
CAFU	5	veery				SI	P			
SIME	14	western bluebird				SI		X		
ANSP	5	water pipit				SI	P			
BOGA	9	Bohemian waxwing				SI	P			
LALU	7	loggerhead shrike						X		
VIOL	11	red-eyed vireo				SI				
VIGI	11	warbling vireo				SI		X		
VECE	6	orange-crowned warbler				SI				
DEPE	8	yellow warbler						X		
DECOR	10	yellow-rumped warbler				SI				
DENI	10	black-throated gray warbler				SI				
OPTO	7	MacGillivray's warbler				SI				
GETR	3	common yellowthroat				SI				
ICVI	8	yellow-breasted chat						X		
SERUT	9	American redstart				SI	P			
DOOR	5	bobolink				SI	P			
STNEG	5	western meadowlark				SI				
PAAMO	7	lazuli bunting				SI				
AMSA	5	grasshopper sparrow						X		

Letter code

E – Endangered
P – Peripheral
R – Rare
SI – Species of special interest
SU – Status undetermined
T – Threatened
U – Unique
X – Occurs on list

Life form

1 Federal Register (endangered)
2 Oregon State (endangered or threatened) (a & b)
3 U.S. Dep. Inter. Fish & Wildl. Serv. "Red Book"
4 USDA FS RNA "Yellow Book"
5 OSU endangered plants and animals of Oregon (a)
6 Audubon – Blue list for 1979
7
8

Appendix 13. Continued

		Species	1	2	3	4	5	6	7	8
AMBI	7	black-throated sparrow								
POGRA	5	vesper sparrow				SI		X		
JUHY	5	northern junco				SI				
PAIL	7	fox sparrow*				SI				
		MAMMALS								
SOPR	16	Malheur shrew				R	R			
SOME	15	Merriam shrew				R	R			
MYEV	14	long-eared myotis				U				
MYTH	4	fringed myotis				R	SU			
MYVO	14	long-legged myotis				R				
MYLE	4	small-footed myotis				R				
LANO	14	silver-haired bat				R				
PIHE	4	western pipistrelle					SU			
LACI	11	hoary bat				R	X			
EUMA	4	spotted bat			T					
ANPA	4	pallid bat				R				
SYID	5	pygmy rabbit				T	X			
LETO	5	white-tailed jackrabbit				U	X			
AMLE	15	antelope ground squirrel					X			
SPRI	15	Richardson ground squirrel				R	X			
PELO	15	little pocket mouse				R				
MIME	15	dark kangaroo mouse					X			
ONLE	15	northern grasshopper mouse				SI	X			
LACU	15	sage vole					X			
VUVU	15	red fox				R				
VUMA	15	kit fox		T	T	T	E			
TATA	15	badger					X			

Letter code

E – Endangered
P – Peripheral
R – Rare
SI – Species of special interest
SU – Status undetermined
T – Threatened
U – Unique
X – Occurs on list

Life form

1 Federal Register (endangered)
2 Oregon State (endangered or threatened) (a & b)
3 U.S. Dep. Inter. Fish & Wildl. Serv. "Red Book"
4 USDA FS RNA "Yellow Book"
5 OSU endangered plants and animals of Oregon (a)
6 Audubon – Blue list for 1979
7
8

Appendix 13. Continued

		Species	1	2	3	4	5	6	7	8
LUCA	16	river otter					X			
FECO	4	puma					X			
OVCA	5	bighorn sheep				U	R			

Letter code	Life form		Federal Register (endangered)	Oregon State (endangered or threatened)	U.S. Dep. Inter. Fish & Wildl. Serv. "Red Book"	USDA FS RNA "Yellow Book"	OSU endangered plants and animals of Oregon	Audubon – Blue list for 1979		
		E – Endangered								
		P – Peripheral								
		R – Rare								
		SI – Species of special interest								
		SU – Status undetermined								
		T – Threatened								
		U – Unique								
		X – Occurs on list	1	2	3	4	5	6	7	8
				(a & b)			(a)			

[1] Columns 7 and 8 have been left blank so that field biologists can fill them in as may be required for local planning efforts.
[2] Population: Western spotted frog.
* May feed in southeast Oregon but is not known to reproduce there. Shown on this list but not on the individual life form lists in other appendices. These are the 12 species listed in appendix 5.
[3] Subspecies: Aleutian Canada goose (*Branta canadensis leucoparela*) may occur in winter.
[4] Subspecies: Tule white-fronted goose (*Anser albifrons gambelli*).
[5] Subspecies: Alaska red-tailed hawk.
[6] Subspecies: *F. s. paulus*.

Appendix 14. Scientific and common names of plant species mentioned in the text.

Common Name	Scientific Name
basin big sagebrush	*Artemisia tridentata tridentata*
bearded bluebunch wheatgrass	*Agropyron spicatum*
big sagebrush	*Artemisia tridentata*
black greasewood	*Sarcobatus vermiculatus*
black sagebrush	*Artemisia nova*
Bolander silver sagebrush	*Artemisia cana bolanderi*
cleftleaf sagebrush	*Artemisia arbuscula arbuscula*
crested wheatgrass	*Agropyron desertorum*
curlleaf mountainmahogany	*Cercocarpus ledifolius ledifolius*
early low sagebrush	*Artemisia longiloba*
Idaho fescue	*Festuca idahoensis*
low sagebrush	*Artemisia arbuscula arbuscula*
mountain big sagebrush	*Artemisia tridentata vaseyana*
mountain silver sagebrush	*Artemisia cana viscidula*
mountain snowberry	*Symphoriocarpos oreophilus*
pinegrass	*Calamagrostis rubescens*
quaking aspen	*Populus tremuloides*
shadscale saltbush	*Atriplex confertifolia*
squaw apple	*Peraphyllum ramosissimum*
stiff sagebrush	*Artemisia rigida*
subalpine big sagebrush	*Artemisia tridentata spiciformis*
threetip sagebrush	*Artemisia tripartita*
western juniper	*Juniperus occidentalis*
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*

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Native Trout

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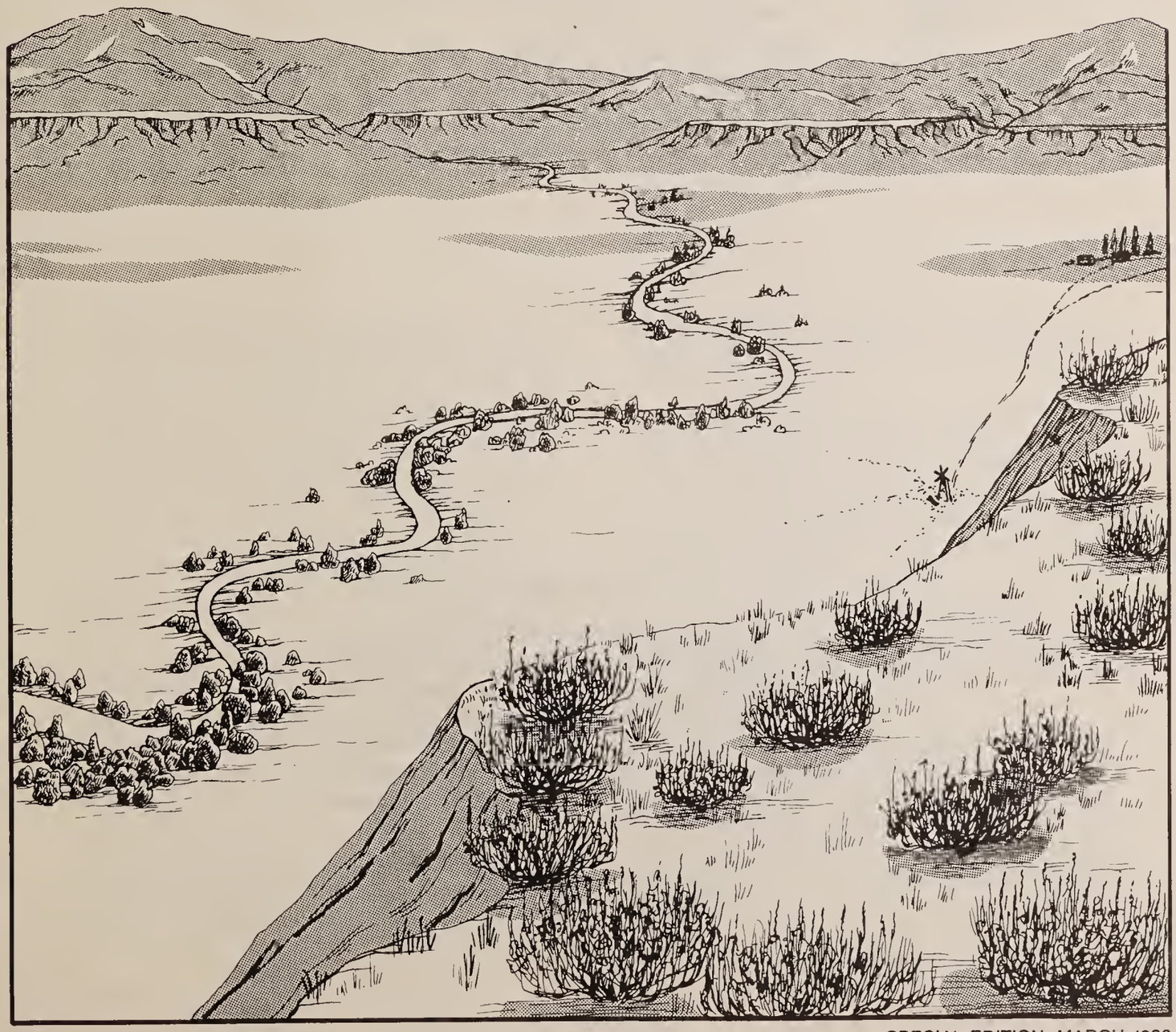
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Native Trout

Wayne Bowers, Bill Hosford, Art Oakley, and Carl Bond



SPECIAL EDITION, MARCH 1986

ABSTRACT

All land management activities on managed rangelands will have some impact(s) on fish habitat; those in the riparian zone will have the greatest impact(s). Native trout populations in the Great Basin of southeastern Oregon exhibit predictable responses to alterations in their habitats; optimum production of native trout is therefore achievable through careful habitat management.

KEYWORDS: Fish habitat, trout, range management.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon**. The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of Southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Southeastern Oregon has a variety of fish habitats which include major rivers, tributary streams, large and small reservoirs, lakes, and springs. These habitats are directly related to and highly dependent on the conditions of the surrounding rangeland watersheds. Satterlund (1975, p. 22) put it this way: "Rangelands may yield little water, but they are second only to cultivated lands as a source of water quality problems." It may be fairly stated, therefore, that man's agricultural activities in rangelands of southeastern Oregon have altered aquatic habitats more than any other land use. And of all the agriculturally oriented activities in southeastern Oregon rangelands, livestock grazing has exerted greater influence on more aquatic habitats than any other land use (Gunderson 1968, Marcuson 1977). Gebhards (1970, p. 3) summed it up:

> Man has gained the knowledge and technical skill that makes him capable of completely altering, or nullifying natures handiwork—but he rarely ponders his inability to duplicate it.
>
> ...Today, through the science of hydrology we know that a stream is in reality the end product of a watershed. Water originating as precipitation flows across and through the surface of the watershed to form the stream. Changes brought about in the watershed by...road construction, overgrazing by livestock, or other disturbances of the land, can greatly alter the pattern of water movement and even water quality within the watershed.

Thirty-eight species of fish are known to occur in southeastern Oregon (Bond 1973) (table 1). Some of these species, including trout (*Salmo* spp.), were once native to most streams. If habitat conditions are or become suitable for good trout production, populations of other indigenous cold-water fish, such as sculpins (*Cottus* spp.), mountain whitefish (*Prosopium williamsoni*), and some suckers (*Catostomus* spp.), will also thrive because their basic habitat requirements are similar (table 2).

Some species, such as bass (*Micropterus* spp.), crappie (*Pomoxis* spp.), and catfish (*Ictalurus* spp.), have been introduced and provide good fisheries. Introduced fish either have occupied habitats which have been altered in a way that favors their living requirements or have occupied natural habitats that are suitable to them but unsuitable or marginal for trout. Introduced species may also partially displace native non-game species, and may pose a threat to sensitive species.

Annual stocking programs have also developed important fisheries in some reservoirs and specific sections of streams. Although such stocking programs will continue to be important, the production of native trout in hundreds of kilometers of streams is considered to be the highest priority and is emphasized in this chapter.

Table 1—Fishes that are known to occur in southeastern Oregon[1]

Trout and Salmon:	
Redband trout	*Salmo* species
Brown trout	*Salmo trutta*
Rainbow trout	*Salmo gairdneri*
Alvord cutthroat	*Salmo clarki* subspecies
Kokanee	*Oncorhynchus nerka*
Coho salmon	*Oncorhynchus kisutch*
Brook trout	*Salvelinus fontinalis*
Dolly Varden trout	*Salvelinus malma*
Mountain whitefish	*Prosopium williamsoni*
Sturgeons:	
White sturgeon	*Acipenser transmontanus*
Sunfishes:	
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Warmouth bass	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Perches:	
Yellow perch	*Perca flavescens*
Catfishes:	
Channel catfish	*Ictalurus punctatus*
Black bullhead	*Ictalurus melas*
Brown bullhead	*Ictalurus nebulosus*
Flathead catfish	*Pylodictus olivaris*
Tadpole madtom	*Noturus gyrinus*
Sculpins:	
Mottled sculpin	*Cottus bairdi semiscaber*
Torrent sculpin	*Cottus rhotheus*
Piute sculpin	*Cottus beldingi*
Shorthead sculpin	*Cottus confusus*
Minnows and Carp:	
Carp	*Cyprinus carpio*
Tui chub	*Gila bicolor*
Lahontan redside	*Richardsonius egregius*
Redside shiner	*Richardsonius balteatus balteatus* also *R. b. hydrophlox*
Longnose dace	*Rhinichthys cataractae dulcis*
Leopard dace	*Rhinichthys falcatus*
Speckled dace	*Rhinichthys osculus*
Chiselmouth	*Acrocheilus alutaceus*
Northern squawfish	*Ptychocheilus oregonensis*
Suckers:	
Largescale sucker	*Catostomus macrocheilus*
Bridgelip sucker	*Catostomus columbianus*
Lahontan sucker	*Catostomus tahoensis*
Mountain sucker	*Catostomus platyrhynchus*

[1]Bond, Carl E., 1974. Endangered plants and animals of Oregon. I. Freshwater fishes. Spec. Rep. 205 (revised), 9 p. Agric. Exp. Stn., Oreg. State Univ., Corvallis.

Table 2—Habitat requirements for fishes of southeastern Oregon. X = habitat(s) where species normally occurs, O = habitat(s) where species can be found

Species	Stream[1]						Large reservoir[3]	Small reservoir or Pond[4]	Lake	Spring
	Small		Medium		Large					
	Cold[2]	Warm	Cold	Warm	Cold	Warm				
Trout & Salmon										
Redband trout	X	O	X	O	X	O	O	O	O	O
Brown trout			X	O	X	O				
Rainbow trout	X	O	X	O	X	O	X	X	O	O
Alvord cutthroat	X	O	X	O						
Brook trout	X		X							X
Dolly Varden trout	X	O	X	O	X	O	O			
Kokanee						O	X			
Coho						O	X			
Mountain whitefish	X	O	X	O	X	O	O			
Sturgeons										
White sturgeon					X	O	O			
Sunfishes										
Smallmouth bass				X		X	X	O		
Largemouth bass				O		X	X	X	X	
Warmouth bass					O	X	X	X		
Bluegill				O		X	X	X	O	
White crappie				O		X	X	X	O	
Black crappie				O		X	X	X	O	
Perches										
Yellow perch				O		X	X	X	X	
Catfishes										
Channel catfish				O		X	X	O		
Black bullhead				O		X	X	X	O	
Brown bullhead				O		X	X	X	X	
Flathead catfish						X	X	O		
Tadpole madtom						X	O			
Sculpins										
Mottled sculpin	X	O	X	O	X	O			O	
Torrent sculpin	X	O	X	O						
Piute sculpin	O	O	X	O	O	O				
Shorthead sculpin	X	O	X	O						
Minnows										
Carp	O	O	O	X	O	X	X	O	O	
Tui chub		O		X		O	X	X	O	
Lahontan redside	X		X	O						
Redside shiner		X		X		X	X	O	O	
Longnose dace	O	O	X	O	X	O	O	O	O	
Leopard dace			X	X	O	O				
Speckled dace	X	X	X	X	X	X	O	O	O	X
Chiselmouth				X		X	X	O	O	
Northern squawfish				X		X	X	O	O	
Suckers										
Largescale sucker			O	X	O	X	X	O	O	
Bridgelip sucker	O	O	X	O	X	O	X	X	O	
Lahontan sucker	X		X	O						
Mountain sucker	X		X		O					

[1]Stream size is based on average width of water (wetted perimeter of streambed or channel) during the summer low-flow period.

Small = Less than 3.04 m (10 feet)
Medium = 3.4 to 7.6 m (11 to 25 feet)
Large = Greater than 7.6 m (25 feet), including main rivers, such as the Snake, Owyhee, and Malheur (lower parts of North and South forks) Rivers.

[2]Cold — Refers to streams with maximal summer water temperatures usually less than 21°C (70°F).
Warm — Refers to streams with maximal summer water temperatures commonly over 21°C (70°F).

[3]Reservoirs over 10.1 surface hectares (25 surface acres) in size and 4.5 m (15 feet) in depth at usual minimum level.

[4]Bodies of water less than 10.1 surface hectares (25 surface acres) in size and 3.04 m (10 feet) in depth at usual minimum level. Includes many small farm ponds.

Objectives

No long-term research has been specifically aimed at the factors affecting trout production in southeastern Oregon, but studies are available that define the habitat components necessary for good trout production, identify limiting factors, and describe land-use conflicts. Data specific to southeastern Oregon and applicable data from other areas are, therefore, synthesized to provide rangeland managers with the information necessary to make the best possible decisions with respect to fish habitat management. Our objectives are to present these data in a way that will assist managers in evaluating trade-offs while achieving short-term management goals, and to present a tool that can be used simultaneously in long-range land-use planning.

Assumptions

In order to fulfill the charge of this chapter it was necessary to recognize the following assumptions:

1. All land management activities will have some impact(s) on fish habitat. Those activities that affect the riparian zone will have the greatest impact.

2. Water quality and habitat conditions in downstream areas are directly affected by land management activities in upstream tributary systems.

3. Trout populations have predictable responses to changes in habitat conditions.

4. If trout habitat is optimal, life requirements of other cold-water species will generally be fulfilled.

5. Because of the increasing public interest in "wild trout," more intensive management of native trout and their habitats will be required in future years. Management will, therefore, be concentrated primarily in the medium- and small-sized tributary streams where most of these fish are found.

6. Because of increasing public concern for certain non-game fishes, land managers will also have to consider management activities that affect those species.

Stream Zones in Southeastern Oregon

Streams in southeastern Oregon generally originate in mountains ranging in elevation from 2 134 to 2 734 m (7,000 to 9,000 ft). As streams descend from the mountains, they pass through three distinctive zones—boulder, floodway, pastoral—and may terminate in a desert sump (fig. 1).

The upper reach of a stream, the boulder zone or headwaters, normally has a steep gradient, falling at a rate of 7.6 m per kilometer (25 ft/mi) or more (fig. 2). This zone is characterized by high velocity water with coarse bedload material and a narrow channel that goes through a steep-walled, bedrock gorge. Vertical erosion of the channel maintains a V-shaped valley.

The gradient gradually decreases as a stream flows into the floodway zone, and there is a corresponding reduction in water velocity (fig. 3). A floodway zone is characterized by a coarse, sand to baseball-sized, sediment load which is constantly shifting, forming gravel bars, islands, and new channels (Palmer 1976). This zone forms floodplains along large streams which are extensively used for agriculture.

In the pastoral zone, which includes the lower reach of a stream, the fine bedload material, silt and sand, forms compacted banks with a deeper meandering channel (fig. 4). Stream banks are often steep and tree-lined. Water velocity is much reduced, and some of the small streams disappear into the ground in what is called a "desert sump" (fig. 5).

Undisturbed stream courses with dense streamside vegetation, stable soils, and moderate gradients—1 to 2 percent—keep water from rapidly descending a stream system. Streamside vegetation is important since it stabilizes streambanks and the movement of sediments; this, in turn, gradually reduces the width of a stream and increases the

Figure 1.—Graphic summary of stream channels of southeastern Oregon streams.

channel depth which creates better habitat conditions for trout (White and Brynildson 1967). Aquatic communities experience a minimum of disturbance where these conditions occur.

Where streamside vegetation is lacking, however, water temperatures rise because of increased exposure to solar radiation. An exposed rock formation, such as canyon walls or especially a bedrock stream bottom, acts as a heat sink that retains heat longer than does the surrounding habitat. Consequently, water temperatures, that would normally decrease rather rapidly after sundown, remain warm for a longer time, particularly on a hot day. Native desert trout can withstand a few hours of high water temperatures, but only if they can find relief in water of cooler temperatures sometime during the day. Where this is not possible,

Figure 2.—The boulder zone is the upper reach or headwaters of a stream which normally has a steep gradient and falls at a rate of 7.6 m per kilometer (25 ft/mi) or more. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

Figure 3.—In the floodway zone there is a gradual decrease in stream gradient and a corresponding reduction in water velocity. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

Figure 4.—In the pastoral zone the lower reach of a stream often has banks that are steep and tree-lined. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

Figure 5.—A desert sump is an area in the desert where a stream terminates and disappears into the ground. (Oregon Department of Fish and Wildlife photograph by Bill Hosford)

their available habitat may be severely restricted or they may be eliminated from a stream.

The best habitat conditions for trout production are generally in the lower boulder and upper floodway zones where water temperatures are cool and riffle-pool ratios are adequate (Elser 1968). As a stream approaches equilibrium in the lower floodway and pastoral zones, new meanders and channels are created. Water temperatures become high, siltation increases, and riffle-pool ratios decrease or are non-existent. Such habitat conditions are more suitable for production of warm-water species of fish than for trout.

Optimum Stream Conditions for Trout Habitat

Native species of trout, adapted to desert environments, have a remarkable ability to survive adverse conditions of high water temperatures, high alkalinities, unusually low streamflows, and marginal spawning areas. These conditions are not ideal and, consequently, trout populations are usually depressed.

If optimal habitat conditions for trout production are considered as management objectives, it should be recognized that not all of them can be achieved in every stream. Some streams, for example, may be too wide for streamside vegetation to provide canopy cover that adequately shades the surface of the water, and alternative management strategies will have to be considered.

The following habitat conditions are optimal for trout production in desert environments:

1. **Water Temperature.** Summer temperatures should not exceed 21°C (70°F). Certain strains of native trout can successfully survive water temperatures of 27°C (80.6°F) for short periods during the day and can also tolerate a 16° to 20°C (30° to 35°F) diurnal temperature fluctuation. Such extremes are not desirable.

2. **Stable Streambanks.** Stable non-eroding streambanks and watersheds are essential to protect spawning gravel, aquatic insects, trout eggs, and recently hatched fry from becoming suffocated by fine sediments, such as sand and silty material (Behnke and Zarn 1976). Acceptable streambanks have 80 percent or more of their total lineal distance in a stable condition.

3. **Streambed Sedimentation.** The riffle-rubble areas of streams are most important for food production and spawning (Cordone and Kelley 1961). At least 75 percent of the total riffle-rubble area in a stream should be free of siltation less than 0.8 mm (.03 in) in size. Furthermore, trout populations will be reduced if pools become filled with sediments which eliminate rearing or hiding areas.

4. **pH Range.** Most good desert trout waters have a pH between 6.5 and 9.0. Although some species of fish can tolerate a higher pH (10 to 10.5), this is not a desirable condition.

5. **Streamside Vegetation.** Streamside vegetation is the most important key in maintaining good trout habitat for several reasons:

a. Streamside vegetation is essential in providing shade which keeps water temperatures from becoming lethal during hot weather (Brown 1976). Such vegetation may consist of trees, shrubs, grasses, sedges or other plants. Streamside vegetation should shade at least 75 percent of the stream surface during the hours of 11 am to 4 pm from June to September, because solar radiation is highest during this time of day and season.

Topography, rocks, and canyon walls can provide some of this needed shade in some situations.

Streambank vegetation also acts as habitat for terrestrial insects which, when they fall into a stream, are an important food source for fish (Butler and Hawthorne 1968, Chapman 1966, Ellis and Gowing 1957, Meehan et al. 1977).

b. Streambank vegetative cover provides protection from erosion during periods of high water. Plant roots help hold soil in place. Stems and leaves bend with the water flow, which reduces scouring and also acts as sediment traps. Sediment traps catch silt before it moves downstream and settles on the more important food-producing and spawning areas of trout.

6. Instream cover is essential to trout for resting, protection from predators, and production of food[1]. Various types of cover, such as boulders, provide instream habitat niches which act as a base for continual fish occupancy. The trout carrying-capacity of a stream, in otherwise good condition, is greatly reduced without adequate instream habitat niches.

Optimal instream cover should be available over at least 50 percent of the total stream area. Such cover may include rocks, turbulent water in pools or riffles, debris, tree roots, overhanging banks, or aquatic vegetation (Boussu 1954).

Overhanging streamside vegetation may augment or replace instream cover provided such vegetation is not more than 60.8 centimeters (2 ft) above the water. Overhanging vegetation should cover at least 50 percent of the streambanks and is particularly crucial on the outside bends of streams.

Effects of Livestock on Fish Habitat

Rangelands of southeastern Oregon have been historically grazed by cattle (*Bos* sp.), horses (*Equus* sp.), and sheep (*Ovis* sp.). Much of this activity was unrestricted and livestock exceeded the carrying capacity of ranges causing severe range deterioration by 1900 (Heady and Bartolome 1977, Foss 1960). Many of the

[1]Binns, Allen N., 1976. Evaluation of habitat quality in Wyoming trout streams. Unpublished paper presented at the Am. Fish Soc., Annu. Meet., Dearborn, Mich. 33 p.

uplands were denuded of soil-stabilizing plants which resulted in extensive sheet, rill, and gully erosion. Extensive down-cutting of stream channels on valley floors was also caused by heavy grazing[2] (Winegar 1977).

In many areas, especially during summer and early fall, riparian zones were extensively overused by livestock because of the lush plant growth and the proximity to water. Continued heavy livestock use of riparian zones produced the following results:

1. Compaction of soils due to livestock trampling caused a reduction of water infiltration, increased water runoff, and made successful reproduction difficult for many species of plants. This, along with a loss of ground cover, caused soil erosion throughout many watersheds.

2. Riparian vegetation needed to provide shade to streams was eliminated, and overhanging streambanks were broken down which resulted in loss of escape cover and accelerated bank erosion.

3. Some highly productive wet meadows have been lost because stream channels have eroded their way down, lowering the water table. This process has resulted in the encroachment of dry-site plant species, such as sagebrush (*Artemisia* spp.). Consequently, small streams that once had adequate flows during summer months are now intermittent or dry, creating a substantial loss of trout habitat.

4. Some streambottoms have been historically burned to eliminate dense vegetation and facilitate the gathering of livestock. This practice has been devastating to the entire riparian zone and associated fish habitat.

5. Coliform bacteria counts are extremely high in some streams due to livestock feces and carcasses. These materials not only impair water quality but also pose potential health problems for recreationists.

Studies have shown that in stream sections where livestock use is light or is eliminated by fencing, production of trout increases substantially. The average increase in fish production was 184 percent for five study areas[3] [4] (Gunderson 1968, Marcuson 1970, Lorz 1974) (fig. 6). These data indicate that trout production in streams currently being heavily grazed

[2]McKinley, Charles, 1965. The management of land and related water resources in Oregon—A case study in administrative federalism. p. 21-31. A manuscript partially supported by a grant to Reed College from the Resources for the Future Inc., Washington, D.C., on file at Dep. of Interior Library, Bonneville Power Administration, Portland, Oregon.

[3]Claire, Errol W., 1977. Fish populations and habitat studies on Camp Creek. Unpublished data on file at Oreg. Dep. Fish and Wildl., John Day.

[4]Duff, Donald A., 1977. Big Creek aquatic habitat management and impacts from livestock grazing. Unpublished paper presented at the Bonneville Chapter of the Am. Fish Soc., Annu. Meet., Ramada Inn, Salt Lake City, Utah. 13 p.

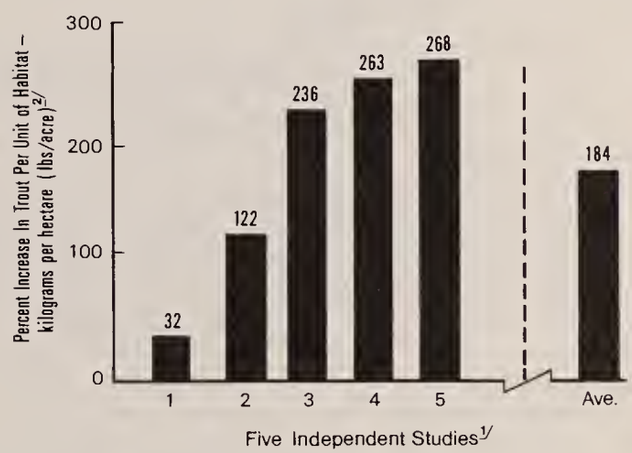


Figure 6.—Percent increase in trout production in areas of controlled or light cattle grazing as compared with heavily grazed areas of the same streams.

[1]**Source:**
1. Gunderson (1968): Rock Creek, Montana—brown trout (*Salmo trutta*) (exclosure).
2. Claire (1977): Camp Creek, Oregon—rainbow trout (*Salmo gairdneri*) (exclosure with controlled grazing).
3. Marcuson (1970): Rock Creek, Montana—brown trout (exclosure).
4. Duff (1977): Big Creek, Utah—rainbow and cutthroat trout (*Salmo clarki*) (exclosure).
5. Lorz (1974): Little Deschutes River, Oregon—brown trout (light grazing).

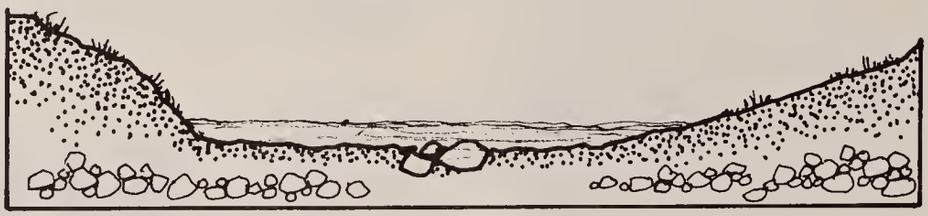
[2]Percent increase of trout in kilograms per hectare (lbs/acre) for all studies except Camp Creek; Claire (1977) reported increase in number of fish per linear distance of stream studies.

could be increased about 200 percent if management decisions were made to optimize habitat conditions for trout.

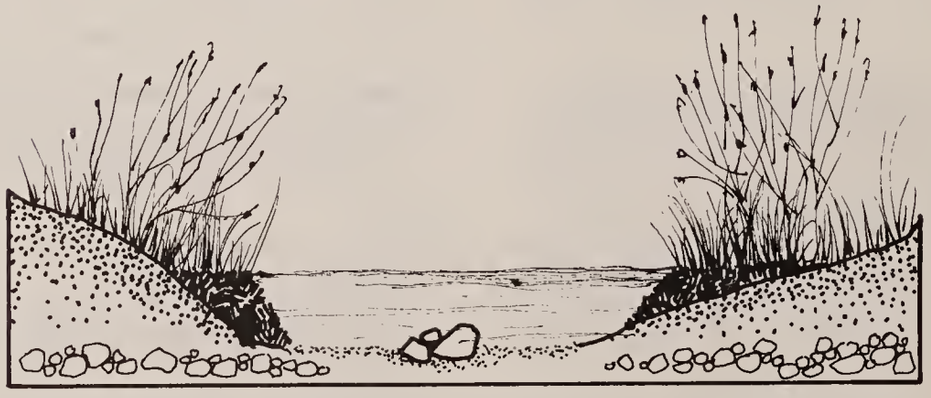
Water temperatures in areas adjacent to exclosures were found to be high; and as a result, such fishes as suckers, dace (*Rhinichthys* spp.), and shiners (*Richardsonius* spp.) were prevalent. In one stream, for example, dace were 4.5 times more numerous in a stream section with season-long grazing use than within a 13-year-old exclosure with controlled grazing (no grazing within the first 6 years and light grazing thereafter). Water temperatures from 26 August to 11 September downstream from the exclosure were 6.7°C (12°F) higher 25.6°C (78°F) than within the exclosure 18.9°C (66°F) (Claire 1977).

Streambank erosion has also been common outside exclosures. Heavily grazed sections generally cause the stream channel to be widened, resulting in decreased water depth and increased water temperature (White and Brynildson 1967, Van Velson n.d.) (fig. 7a). Figure 7b and 7c illustrate the natural stream

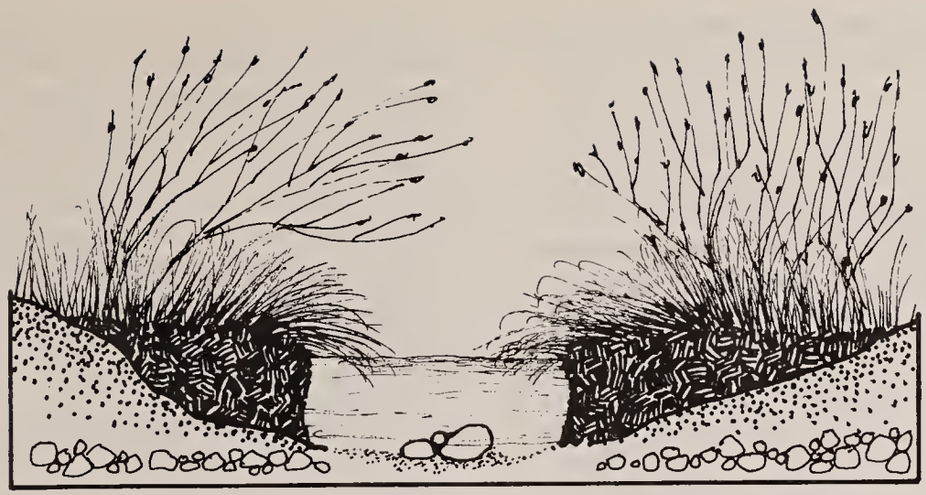
Figure 7.—Stream habitat conditions with heavy grazing (A) and subsequent improvement over a 10-year period—providing livestock grazing is discontinued (B and C). Adapted from White and Brynildson (1967).



A. Late summer stream conditions with heavy livestock use: Bank vegetation and aquatic vegetation grazed and trampled. Banks eroded and streambed mostly covered by shifting sediment. Water and streambed exposed to sun. These conditions offer trout no cover, no place to spawn, little food, unfavorable temperatures, and turbid water.



B. Late summer conditions after 2 to 3 years without grazing: Streambank vegetation includes grasses, young willows, wild rose and alder—vegetation binding soils, sediment being deposited, and stream receiving some shade. Trout habitat improved with increased cover, more food, and better spawning conditions.



C. Late summer stream conditions after 5 to 10 years of non-use by livestock: Streambanks are well vegetated with 2.4- to 4.6-m- (8- to 15-foot-) high willow, wild rose, alder, cottonwood, red osier dogwood, grasses, shrubs, and sedges. Stream has numerous overhanging banks with little sediment movement. Excellent trout habitat providing cover, cold water, food, and spawning area.

processes that restore degraded habitats to productive conditions when grazing use is eliminated for a number of years (fig. 8).

Although no documentation was found, it seems to be obvious that any wild herbivore using the riparian zone is going to have an effect on the condition, species composition, and growth of the plant community.

Figure 8.—Natural processes can restore degraded habitat to a productive condition for native trout when livestock grazing is eliminated. (Photograph by Robert R. Kindschy)

Management Tips

Livestock grazing is the dominant land management program on public lands in southeastern Oregon. Most of the tips concern this land use, and are designed to assist a manager in making decisions that are beneficial for trout production.

The previously discussed optimal habitat requirements for trout are repeated here as generalized objectives, the achievement of which will lead to good trout habitat:

1. Where possible, streams should be 75 percent or more shaded with a vegetative canopy cover to maintain summer water temperatures below 21.1°C (70°F).

2. Streambanks should be well vegetated to prevent active erosion from occurring on at least 80 percent of their total lineal distance.

3. Instream cover for trout should be about 50 percent of the total stream area, including overhanging bank vegetation on 50 percent or more of the streambanks.

4. At least 75 percent of riffle-rubble areas of streams should be free of siltation or fine sediments.

Attainment of all of these goals on all streams may not be possible because of various site-specific limitations on particular streams. Specific actions that may be taken to maintain or improve native trout habitat are as follows:

1. Implement grazing systems that will create and/or maintain the requirements for good condition trout habitat. Livestock management alternatives that should be considered to improve degraded stream habitats and riparian zones include: (a) deferred grazing on streamside areas until fall months, and (b) on high priority streams, schedule exclusion of riparian areas from livestock grazing until substantial habitat improvement has occurred—this may require from 5 to 10 years, depending on the existing conditions of the habitat. Permanent elimination of livestock grazing in most areas is neither desirable nor feasible, but grazing should be closely controlled to improve habitats in poor condition and to maintain healthy riparian vegetation and productive fish habitat.

2. Fencing may be necessary on the most important trout streams to protect the easily damaged habitat. The entire riparian zone should be excluded from pastures in these areas. Corridor fences are usually considered undesirable but can be used to obtain immediate improvement in small areas where streambank erosion is a serious problem. Gap fences, less expensive to erect, often require annual maintenance.

3. Encourage livestock use away from riparian zones. Management practices, such as salting, water developments, and herding, can relieve pressure on riparian zones and markedly improve upland range conditions.

4. Artificial revegetation of streambanks may produce vegetative recovery more rapidly than natural revegetation. Recovery of critical streamside cover can be accelerated by several years when trees, shrubs, and grasses are planted. Plantings in the riparian zone should include willow (*Salix* sp.), alder (*Alnus* sp.), cottonwood (*Populus* sp.), quaking aspen (*Populus tremuloides*), black locust (*Robinia pseudoacacia*), chokecherry (*Prunus virginiana*), Russian olive (*Elaeagnus angustifolia*), red-osier dogwood (*Cornus stolonifera*), reed canary grass (*Phalaris arundinacea*) (Rise variety), streambank wheatgrass (*Agropyron dasytachyum*), and yellow-blossom sweet clover (*Melilotus officinalis*). Research is needed, however, to develop varieties of riparian plants that are less palatable to livestock.

5. Stream improvement structures should be installed only after a thorough field evaluation. Recommendations of both hydrologists and fishery biologists should be included in project planning. Recommended structures for streams are trash catchers, gabions, small rock dams, individual boulder placement, rock jetties, and silt-log drops. The type of instream structure recommended will depend on site-specific conditions of each stream. Some structures could serve the dual purpose of increasing the water table in areas of former wet meadows as well as improving trout habitat.

6. Riparian vegetation should be protected during herbicide treatments designed to improve range forage for livestock use. Certain chemicals are toxic to fish and other aquatic organisms. Use of streamside buffer strips and adherence to all other standard procedures for herbicide applications, including close contract supervision, are imperative.

7. Controlled beaver (*Castor canadensis*) populations are an asset to small trout streams and their attendant wildlife (Kirby 1975). They help retain water, influence the water table in the streamside zone, and provide some good pools for trout. A regulated trapping harvest is essential to maintain healthy beaver populations compatible with good trout habitat. Regulation of livestock grazing is also essential to perpetuate viable stands of aspen and willow (DeByle 1976, Schier 1976, Smith et al. 1972).

Uncontrolled beaver populations may be destructive to trout habitat on some higher elevation streams. Beaver can completely cut down large aspen groves and willow patches (Hall 1960). After food supplies are eliminated, the beavers either move or die of starvation.

In southeastern Oregon, for example, riparian aspen groves are small, relatively rare, and are easily eliminated by the combination of beaver and livestock use. Consequently, many aspen groves have little or no regeneration or regrowth because young plants are eaten by livestock before they become well-established. Since aspen regeneration is through adventitious shoots, root suckers, or root sprouts, there are ways to rejuvenate a declining grove that is not subject to either beaver or livestock use (Jones 1975, Jones and Trujillo 1975, Schier 1975, 1976). Where beaver or livestock use an aspen grove, however, exclusion of livestock will be necessary for a long enough period of time to allow the young aspen to become established and large enough to withstand livestock use.

Extensive soil erosion may occur within the former aspen-willow areas, and beaver ponds usually become filled with sediment. Old beaver dams may eventually break and discharge heavy sediment loads downstream.

8. Improvements of existing roads or construction of new roads along streams inhabited by native trout could have severely adverse effects upon these fish populations (Whitney and Bailey 1959). Roads along streams destroy the riparian vegetation and thereby remove trout cover and increase water temperatures. Further, sediment movement into streams from roads, particularly road construction, is detrimental to aquatic life. If streamside road construction is unavoidable, however, culverts should be placed so as to minimize erosion and provide easy fish passage.

Improved, well-developed roads usually result in better access and heavier public use. Wild trout, therefore, are generally less abundant in areas where streams are easily accessible.

9. Recreation use will continue to increase in southeastern Oregon. It is suggested, therefore, that developed recreation facilities should not be constructed on any native trout stream because of the tendency to overfish a stream. New recreational facilities should be located in the more accessible areas where fish populations can be maintained either by stocking hatchery trout or with warm-water species.

In addition, if viable trout populations are to be maintained, the construction of trails along native trout streams is not recommended.

10. Water management of large reservoirs occurring on or adjacent to public lands in southeastern Oregon are under the control of the Bureau of Reclamation and/or irrigation districts. Because of this, available options to manage fish habitat must be related to the surrounding lands and upper watersheds. If the surrounding rangelands are in good condition, erosion will be minimized and water flowing into reservoirs will be of sufficient quality to maintain good fish populations.

Small reservoirs, constructed for stock water developments, sometimes have water conditions suitable for fishery development. If water-gap fences are used to keep livestock out of small reservoirs, they may cause maintenance problems. For example, ice breaks such fences; and where reservoirs fluctuate, livestock often get around the ends of the gap fence. Fencing may be necessary, therefore, to exclude livestock from the entire reservoir area. Water can then be piped to a livestock watering trough outside of the fence.

11. Springs that help maintain water quality and quantity in downstream fish habitats, especially during summer low-flow periods, should be protected. Furthermore, isolated springs in the desert environment of southeastern Oregon sometimes contain unique or rare species of fish.

12. Each spring, the Oregon Department of Fish and Wildlife stocks the larger reservoirs, parts of the Malheur River, and many of the smaller water developments with fingerling rainbow trout. Streams that are easily accessible and support heavy angling pressure may receive legal-sized rainbow trout each year. To help maintain strains of wild trout, hatchery trout should not be released in streams where native trout occur.

Habitats not suited for trout production, but with fishery potential, may be stocked with warm-water game fish if there is no adverse impact on native non-game species.

Land managers should contact the local fisheries biologist if they think some of their water developments are suitable for fish production. If a reservoir is found to be suitable habitat, the Department of Fish and Wildlife will stock the desired species and manage the fishery.

Management practices—on any part of a rangeland watershed—ultimately affect the riparian vegetation, water quality and quantity, and fish habitat. Proper resource management, especially livestock grazing, is imperative if we are to insure the welfare of our aquatic habitats and their riparian zones. Streams, rivers, lakes, and their attendant riparian zones are the barometers that reflect the care man takes of his land-support base. Spence (1938, p. 23) summed it up:

> ...Is it not wiser, under any condition, to suffer now and begin to rebuild on investment than to continue to gamble year after year, and finally end with a total loss...? The problem becomes even more serious when the welfare to future generations is considered.

Fortunately, natural processes not only can help restore streams that are in poor condition but also can help reverse the downward trend of stream habitats. With the existing knowledge of natural processes, management strategies can be tailored to improve stream habitats; but their maintenance and repair will require the cooperative efforts of both public and private rangeland managers because streams ignore political boundaries.

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Sage Grouse

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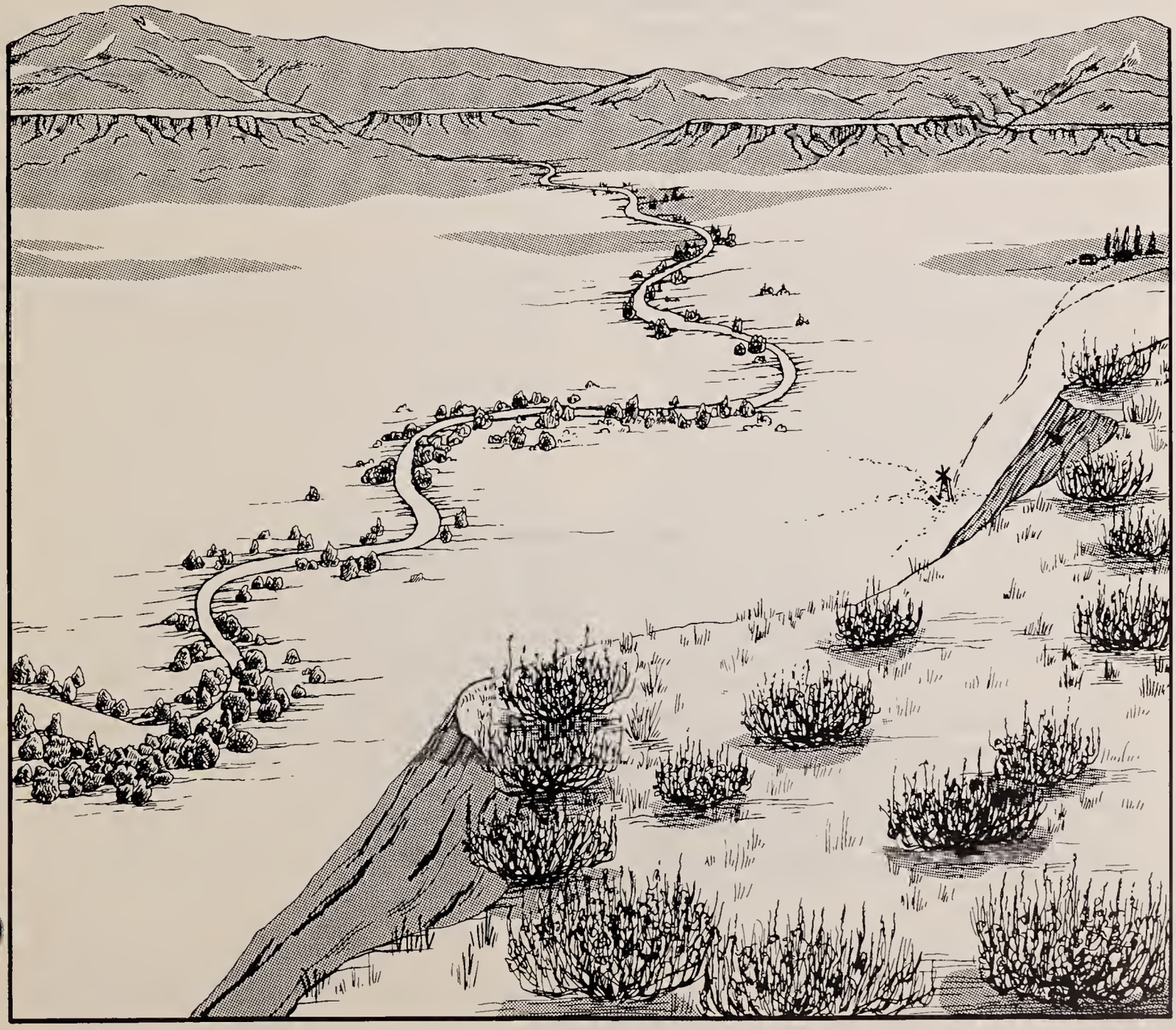
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Sage Grouse

Mayo W. Call and Chris Maser



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ABSTRACT

Survival of sage grouse populations in Oregon and throughout the West depends on the maintenance of essential habitat components to meet the seasonal needs of grouse. The array of habitat components and some management tips to help perpetuate quality habitat for the grouse are presented.

Keywords: Habitat needs, wildlife habitat management, range management, sage grouse, Oregon (Great Basin).

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

The sage grouse[1] is one of the habitat-specific birds of the West. It relies primarily on one particular plant type—sagebrush—to meet its life requirements (Patterson 1952). Studies of the food habits of sage grouse throughout their range reveal dependence on sagebrush from October through April. In May, sage grouse shift to a diet dominated by forbs, and in September they go back to sagebrush (Bean 1941, Dargan et al. 1942, Girard 1937, Griner 1939, Klebenow and Gray 1968, Oakleaf 1971, Peterson 1970a, Wallestad et al. 1975).

Sage grouse occur throughout the range of big sagebrush, but their numbers are now reduced, and they have disappeared from peripheral areas where sagebrush has been extensively removed (U.S. Department of the Interior, Bureau of Land Management 1970) (figs. 1 and 2). A considerable reduction in numbers has occurred as a result of settlement, but they have been extirpated in British Columbia and maybe in Arizona (Patterson 1952). Both the eastern and western subspecies are found in the Great Basin in Oregon (Masson and Mace 1974).

The distribution of sage grouse is not continuous because of the interspersion of forested mountainous areas. Historically, as today, sage grouse were commonly found near mountains. High plateaus and intermountain valleys provide the best conditions for survival of sage grouse (Patterson 1952).

Martin et al. (1951) estimated that more than 50 percent of the original sage grouse habitat had been eliminated. By 1967, 1.97-2.36 million ha (5-6 million acres) of rangelands had been treated to reduce sagebrush (Schneegas 1967). Hundreds of thousands of additional hectares (acres) have been modified since 1967. Sagebrush has been sprayed, plowed, chained, burned, disked, cut, or beaten to convert the land to grassland (fig. 3). Heavy grazing by domestic livestock, irrigation projects, dry land farming, seeding, and miscellaneous factors have played a part in altering original habitats (Rogers 1964).

[1]Common and scientific names are listed in the appendix.

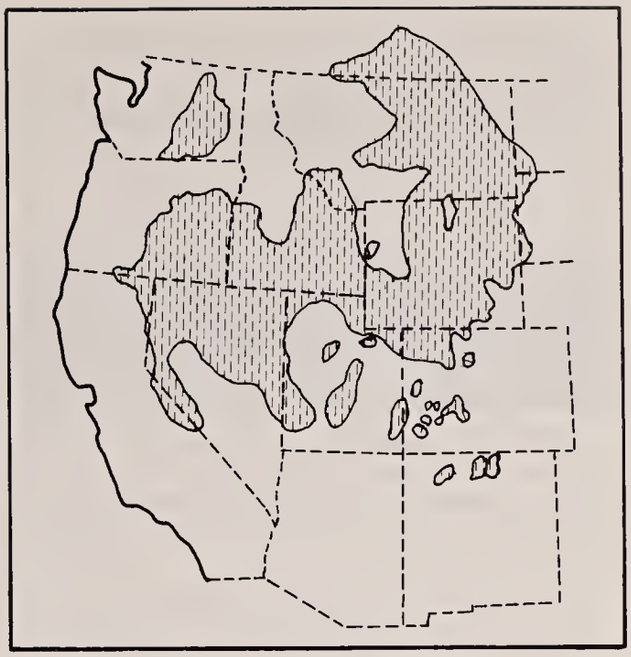

Figure 1.—Sage grouse distribution in North America in 1975 (after Wallestad 1975).

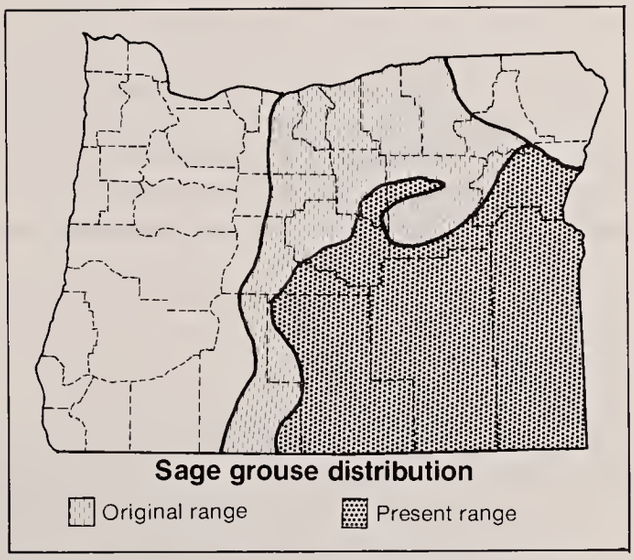

Figure 2.—Sage grouse distribution in Oregon in 1974 (after Masson and Mace 1974).

Figure 3.—Aerial spraying of herbicides has been one of the most common methods for killing sagebrush. Increased grass production for livestock results, but habitat for sage grouse may be eliminated.

Decreases in sage grouse followed the decrease in sagebrush. Other factors, such as unfavorable weather conditions at hatching time and increased predation, hunting, and disease have each been important at various times in localized areas but are probably not the most important factors in the overall downward trend.

The major factor that most adversely affects wildlife populations over the long term is the loss, in quality or quantity, of habitat (Call 1979). The number of sage grouse can be expected to decrease in areas where human populations and agricultural developments are expanding. In earlier years, habitat losses occurred primarily from the effects of heavy grazing by livestock or from programs that reduced sagebrush and increased grass production. More recently, habitat losses are occurring because of strip mining for coal, development of oil and gas fields, industrial developments, and related activities. The people required to operate the facilities often disturb surrounding lands so they are no longer suitable for grouse.

There has also been maximum exploitation of surface water for irrigation, mining, and other domestic purposes; entire streams have sometimes been diverted. In other instances the application of water to lands unsuitable for cultivation resulted in leaching of alkali salts that polluted stream courses and converted sagebrush lands into salt shrub areas (Patterson 1952).

Sage grouse suffered the same losses of habitat in Oregon as in other States. From 1934 through 1983, 157 198 ha (388,144 acres) of vegetation were treated to increase grass production in southeastern Oregon (U.S. Department of the Interior, Bureau of Land Management 1983). In addition, wildfires have altered large areas of sage grouse habitat, at least temporarily.

Sage grouse fluctuated considerably in different areas over the years.[2] The most important factors influencing productivity and survival are conjectural—predation, forb production, weather, hunting, and habitat changes.

Sage grouse have not adjusted, and probably will not adjust, their life processes to fit a pattern of land use that eliminates or adversely disturbs large tracts of sagebrush to which they are tied for food and nesting cover.

Fortunately, some changes resulting from livestock grazing, agricultural practices, and other land uses may have benefited sage grouse. The creation of openings in large sagebrush stands, from whatever causes, produced feeding and brooding areas and may have benefited sage grouse especially where water is close by. The creation of meadows (or meadowlike areas) within sagebrush stands improved the summer food supply of sage grouse. Where land use practices removed large, decadent sagebrush stands and permitted development of new, young plants, sage grouse habitat may have been improved. But the overall habitat is generally better where patches or strips of tall, dense sagebrush are retained for use as escape cover or for roosting.

[2]J. A. Crawford, Oregon State University, Corvallis, personal communication.

Assumptions

In this chapter, we define cover and forage components of optimum sage grouse habitat and describe how changes in plant community structure and composition affect habitat quality. Optimum habitat for sage grouse may not always be maintained because of other resource needs and uses, but compromises to meet the needs of the grouse can be made. Our intent is to help rangeland managers evaluate impacts and trade-offs of habitat manipulations for sage grouse.

We have made these assumptions:

1. Eastern and western sage grouse subspecies in Oregon have similar habitat requirements and respond similarly to habitat alterations.
2. Where there are conflicts between sage grouse and livestock on public lands, it may be essential to give priority to sage grouse if they are to continue to exist on these areas.
3. Research results and management principles are applicable for sage grouse from other areas provided modifications are made to account for local circumstances.
4. Oregon has different subspecies or varieties of sagebrush than those found in some other Western States, so there may be differences in sage grouse use of various subspecies of sagebrush for food and cover. Habitat management principles, however, remain essentially the same.
5. The needs of sage grouse will take precedence over livestock on important brood-rearing areas to ensure adequate food.
6. Land uses can be tailored to provide areas of sufficient size to maintain viable populations of sage grouse.

Habitat Requirements

Sage grouse densities vary in the Great Basin of southeastern Oregon, depending on the subspecies and structure of the sagebrush, composition and density of the understory vegetation, intensity of livestock grazing, presence of water, and human disturbance. Some of the general habitat requirements of sage grouse on sagebrush-grasslands follow.

ABIOTIC FACTORS

Topography

Although some forms of sagebrush grow on shallow, rocky soils found on ridges and sidehills, the most vigorous stands occur on the deeper soils of valleys and gently rolling terrain. Sage grouse depend primarily on sagebrush for cover, so most sage grouse are found in sagebrush habitats where slopes are less than 30 percent, although they are occasionally encountered on steeper slopes (fig. 4). Sage

Figure 4.—Low, rolling hills and adjacent valleys provide the best topography and habitat for sage grouse, especially where patches of big sagebrush are intermixed with areas of low sagebrush. Sage grouse commonly move to higher elevations to find more succulent forbs as summer progresses.

grouse often follow the development of succulent forbs by moving from valleys to higher elevations during early summer (Batterson and Morse 1948, Nelson 1955, Patterson 1952). Exceptions to such movement occur. Batterson and Morse (1948) noted that migrations in Baker County, Oregon, for example, involved movement down to the valleys in summer, up to the hills in late fall, and down to the strutting grounds in late winter.

Barriers to Movement

There are no known barriers that prevent the occupation of suitable habitat by sage grouse. If they are not found in good habitats, they likely have been extirpated.

Elevation

The best populations of sage grouse in the Great Basin of southeastern Oregon are between elevations of 1220 and 2438 m (4,000 and 8,000 ft), although individuals and small groups may be found at lower elevations.[3]

Climate

The highest densities of sage grouse occur where precipitation averages 25-38 cm (10-16 in) per year. Marginal populations occur in areas of lesser precipitation.

Water

We believe that free water is an essential component of sage grouse habitat. The need for free water in summer, however, probably depends on: (1) the amount of available, preferred, succulent vegetation produced; and (2) how early in summer the preferred forbs dry out. Other authors (Autenrieth 1981, Girard 1935, Griner 1939, Savage 1969) also consider free water essential, but a few do not (Batterson and Morse 1948, Nelson 1955, Trueblood 1954). For instance, Griner (1939) stated that all of the 161 nests he found were within 0.8 km (0.5 mi) of water. Keller et al. (1941) reported no preference for slope, exposure, or nearness to water. Patterson (1950) stated that nesting density was slightly higher on areas adjacent to main irrigation canals and creeks than on areas 1.6 to 3.2 km (1 to 2 mi) from running water. Girard (1935) found that sage grouse broods need water within a few hours after hatching and, consequently, move immediately to stream areas. Batterson and Morse (1948) raised a brood of chicks to 4 weeks without giving them free water, and without apparent ill effects. Trueblood (1954) believed that sage grouse chicks obtain most of their water from succulent vegetation and dew in years of above-average rainfall.

Nelson (1955) noted no connection between selection of nest site and the presence of water. The majority of the nests he observed were on sagebrush flats 1.6 to 4.8 km (1 to 3 mi) from the nearest permanent source of water. He stated, however, that spring rains and snows create many small standing pools in places with poor drainage, as well as in rock depressions. Consequently, there may be no need for sage grouse to move to permanent sources of water during most of the nesting period.

Migrating grouse gather around waterholes and in meadows along fall migration routes in Idaho. Although daily movements are modified by weather conditions, grouse often wait near waterholes until 0700 or 0800 h and then drink. Watering lasts 10 to 30 min (Dalke et al. 1963). Knowing that grouse use waterholes early in the morning in autumn, hunters frequently kill grouse at such places, especially where meadows are nearby.

Sage grouse regularly visited partially frozen streams in Eden Valley, Wyoming, in late fall to drink through holes in the ice. Ranchers told stories of flocks coming into their yards and drinking from livestock watering troughs (Patterson 1952).

Sage grouse may do well in the absence of free water where they have access to succulent vegetation. Moisture requirements are partially fulfilled through metabolic processes, and as vegetation (forbs) dries in late summer and fall the birds tend to move to areas where free water is available. High temperatures and the associated heat stress induce grouse to seek free

[3]R. R. Kindschy, Bureau of Land Management District Office, Vale, Oregon, personal communication.

water sources by early July in some years (Savage 1969). In winter, snow takes care of their moisture requirements, either directly or as it melts and provides free water.

BIOTIC FACTORS

Vegetation

A habitat manager must account for seasonal needs of sage grouse. For example, deep snow covering the spring and summer ranges may force the birds to migrate to some distant range for winter, only to return for nesting as snow depth decreases (Rogers 1964, Wallestad 1975). Where sage grouse nest and raise broods on sagebrush-covered mountain slopes or in high mountain valleys, they usually migrate to lower valleys in winter to find exposed sagebrush for food. This is common in Wyoming, Colorado, and Idaho but less true in southeastern Oregon where winters are milder and snow seldom covers sagebrush plants deep enough to make locating food a serious problem.

Vegetation structure and composition on leks (strutting grounds) differ from the vegetation complex on wintering areas or in nesting areas. Dense, tall sagebrush is seldom used for nesting cover (Patterson 1952) but is frequently used as loafing cover or as protective cover during severe winter storms (Beck 1977). In general, good habitat for sage grouse should contain openings less than 274 m (300 yd) in circumference, some dense sagebrush stands, and about equal amounts of tall and short sagebrush plants (Rogers 1964).

Breeding Habitat

In late February and early March, cocks begin moving from wintering areas to traditional leks. A few weeks later hens congregate at these sites for courtship and mating. Leks are usually small open areas from 0.04 to 4 ha (1/10 to 10 acres) in size, but they may be as large as 40.5 ha (100 acres) or more (Call 1979).

Leks may be located at a point intermediate between the winter and summer range. In some cases, the summer and winter range may be the same area. Sage grouse prefer relatively open areas as leks (Call 1979, Keller et al. 1941, Patterson 1952, Rogers 1964, Schlatterer 1960, Scott 1942, Wallestad 1975). Although sagebrush usually surrounds a lek, it may be low and sparse or dense (Scott 1942, Wallestad 1975). Grassy swales, natural and irrigated meadows where grass has been removed or grazed, burned areas, cultivated or natural fields adjacent to sagebrush-grass rangelands, cleared roadsides, abandoned homesteads, dry lakebeds, bare areas around small reservoirs, barren ridges, swales, bottom lands, and other open areas on all exposures may be used for strutting and mating (figs. 5, 6, and 7).

Barring complete obliteration of the physical aspects of a lek itself, generation after generation of birds will use the same lek. Occupancy of individual grounds usually extends over many years, although in the interim, new grounds are established by young birds, and others are probably passing out of existence because of changes in habitat or disintegration of a local male population. There may also be a gradual shift of sage grouse use between leks over a long period. A shift in use of leks, small ones being abandoned and large ones increasingly used, may occur toward the end of the breeding season (Dalke et al. 1960, Patterson 1952, Wiley 1973). One lek in Idaho may have been used for 90 years, although not necessarily continuously; this conclusion is based on the finding of broken arrowheads used for hunting birds. Use of such leks year after year depends on the size of the grouse population for any given year. Larger grounds may be used each year, whereas smaller ones may be temporarily abandoned when populations are low (Dalke et al. 1963).

Sage grouse apparently prefer leks adjacent to dense brushy cover. Such cover is undoubtedly important during strutting when the birds are exposed to predators, particularly raptors (fig. 8). The loss of surrounding food and cover may cause a lek to be abandoned (Carr 1968, Trueblood 1954).

Loafing and roosting sites near leks invariably support the heaviest and densest sagebrush (Patterson 1952). Optimum loafing sites are found along stream bottoms, ravines, and draws. Wallestad and Schladweiler (1974) recorded sagebrush height and canopy cover at

Figure 5.—Bare, open areas are commonly selected as sage grouse leks (Oregon Department of Fish and Wildlife photograph by A. L. Miller).

Figure 6.—Open areas of low vegetation may be used for breeding activities.

Figure 7.—Note hens on strutting grounds for breeding; they then move to outlying areas for nesting.

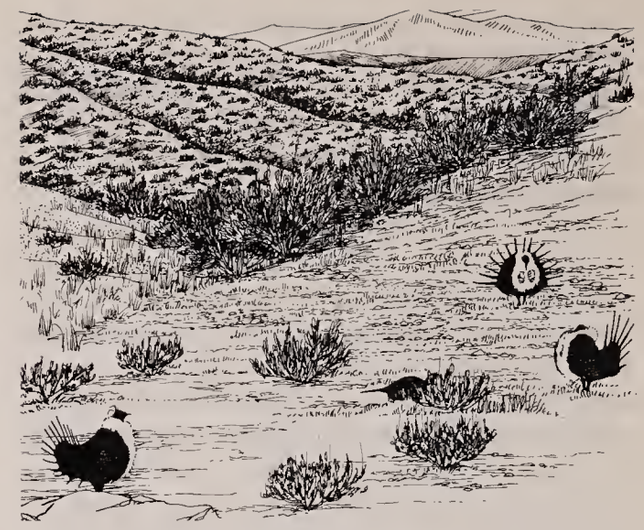

Figure 8.—Sage grouse apparently prefer leks adjacent to dense brushy cover.

110 feeding and loafing sites of cocks; 80 percent of the locations occurred in sagebrush with a canopy cover of 20-50 percent (this is also the range of canopy for which vegetation control is likely to be recommended to enhance livestock production).

Grouse may spend the day within 1.6 km (1 mi) of the leks, or they might move 3.2-4.8 km (2-3 mi) away (Batterson and Morse 1948, Scott 1942). The cruising radius of sage grouse in Idaho during the strutting season was thought to be less than 0.8 km (0.5 mi) (Pyrah 1954), whereas in Montana male grouse commonly moved up to 1.3 km (0.8 mi) from leks (Wallestad and Schladweiler 1974). Adult males in Colorado rarely ventured farther than 366 m (400 yd) from leks, but near the end of the strutting season they moved outward as much as 1.6 km (1 mi). Because sage grouse feed primarily on sagebrush during the early part of the mating season, they are more likely to abandon a lek if an adequate supply of food is not available within at least 1.6 km (1 mi). Although sage grouse may move a kilometer or more for food, they probably would not readily move that distance without adequate cover. Sagebrush should therefore be protected to a radius of at least 2.4 km (1.5 mi) from leks (Carr 1968, Gill 1965, Wallestad and Schladweiler 1974).

Figure 9.—Sage grouse nests are usually placed between or under sagebrush plants with some overhead cover (photograph courtesy of Dick Kerr).

Nesting Habitat

Sage grouse hens build nests in the vicinity of a lek within 7 to 10 days after breeding. The nest is frequently constructed between the lek and the area that will be used for brood-rearing and summering (Autenrieth 1981, Braun et al. 1969, Wallestad 1975). Nests are made by scratching out a shallow depression, usually beneath or between sagebrush plants, that is lined with dead grass, sage twigs, and feathers (fig. 9).

Egg laying normally begins about mid-April. A few renesting hens do not complete clutches until mid-May. Incubation takes 25 to 27 days; the peak of hatching varies from the last week in May to the second week in June. The mean hatching date in Oregon is the second week of June; 20 to 30 percent of hatching occurs in May and 15 to 20 percent in July (see footnote 3). Average clutch size is six to eight eggs. A few nests have as many as 12 eggs (Patterson 1952).

A basic requirement of nesting cover is concealment of the hen and her nest (Autenrieth 1981, Girard 1935, Keller et al. 1941, Patterson 1952). Nest locations are apparently related to cover condition. Autenrieth (1981) found that when good nesting cover was available near a lek, the proximity of the nest to the lek tended to be less than when sagebrush was sparse and found only in clumps. The proximity of 306 nests to a lek was (cumulative percentages): 0-1.6 km (0.96 mi), 28.4 percent; 0-3.2 km (1.92 mi), 59.0 percent; 0-4.8 km (2.88 mi), 73.4 percent; 0-6.4 km (3.84 mi), 85.0 percent; 0-8.0 km (4.80 mi), 96.2 percent; 0-9.6 km (5.76 mi), 97.2 percent; 0-12.8 km (6.72 mi), 100 percent.

Nest sites are usually located within 3.2 km (2 mi) of a lek. Wallestad and Pyrah (1974) found that 68 percent of all radio-marked hens in Montana nested within 2.4 km (1.5 mi) of a lek; one nest was found 9.1 km (5.7 mi) from a lek. Rogers (1964) reports an unusual situation in Colorado where hens traveled from 24 to 32 km (15 to 20 mi) from the lek to nest. Hens would visit leks until bred and would then move into a vicinity close to the location of the final nest site and remain relatively sedentary until they nested. Braun et al. (1969) stated that hens in Colorado tended to make their nests in the direction of the brood-rearing and summering areas after leaving the breeding grounds.

The specific use of sagebrush as nesting cover has been documented as follows: Wyoming, 92 percent of approximately 300 nests were under sagebrush (Patterson 1952); Colorado, 92 percent of 117 nests (Gill 1965); Wyoming, 50 nests (Girard 1937); Colorado, 94 percent of the nests (Keller et al. 1941); Idaho, 35 nests (Gray 1967); and Montana, 100 percent of the nests (Wallestad and Pyrah 1974).

Some biologists believe that dense vegetation and undergrowth are preferred for nesting (Dargan and Keller 1940; Rasmussen and Griner 1938); others stated that isolated plants and open stands were favored (Batterson and Morse 1948). Patterson (1952) thought that hens preferred to nest in short sagebrush of medium density, such as is found on drier sites, in preference to the dense, tall brush found along watercourses and on moist sites. In Idaho the number of big sagebrush plants per 0.4 ha (1 acre) of nesting habitat ranged from 4,960 to 10,790 (Autenrieth 1981), and in Montana the number of sagebrush plants within 68 cm (24 in) of successful nests was 6.4 (Wallestad and Pyrah 1974). Patterson (1952) was probably referring to sagebrush from 30 to 80 cm (12 to 15 in) in height and from 6,000 to 8,000 sagebrush plants per 0.4 ha (1 acre) in locations that would permit a quick and unimpeded escape for a hen.

Most nests are hidden from above by branches that provide an umbrella effect (Autenrieth 1981, Batterson and Morse 1948, Girard 1935, Nelson 1955, Patterson 1952). Although large, full sagebrush plants are not always used for nesting cover, good growth of understory grasses aids in nesting success because it helps conceal nests from aerial predators and contributes to a microclimate that is warmer than the air temperature 1 m (39 in) above the nest. Nest temperature drops less during a hen's absence where the understory is greatest. Hens usually leave the nests to feed for brief periods twice daily—0430 to 0630 and 1800 to 1900 (Autenrieth 1981; Girard 1935, 1937; Nelson 1955; Rasmussen and Griner 1938).

Wallestad and Pyrah (1974) compared the characteristics of sagebrush around 31 successful and 10 unsuccessful nests. A significantly greater cover of sagebrush within 60 cm (24 in) of the nest within a 9-m^2 (100-ft^2) plot was around successful nests (6.4 sagebrush plants compared with 4.5 for unsuccessful nests); and successful nests were located in stands of sagebrush with a higher average canopy cover (27 percent) than that of unsuccessful nests (20 percent). Patterson (1952) found nesting density to be lower on an overgrazed area than on an ungrazed area (one nest per 9.5 ha (23.5 acres) compared with one nest per 3.6 ha (9 acres)) and implied this was due to reduced ground cover, other than shrubs.

Height of sagebrush commonly used for nesting ranges from 17 to 79 cm (7 to 31 in). Most nests are located under the tallest bushes available at a particular site (Autenrieth 1981; Braun et al. 1977; Gray 1967; Keller et al. 1941; Klebenow 1969; Patterson 1950, 1952; Schlatterer 1960; Trueblood 1954; Wallestad and Pyrah 1974). Stands with 20 to 40 percent canopy cover are most frequently selected for nesting (fig. 10). Many studies do not give the average sagebrush height that predominates in the area, but those that do indicate preference for the higher plants under which to place nests (table 1). The variety of sagebrush species and subspecies that occur suggests that sage grouse will nest in sagebrush of different heights in different community types.

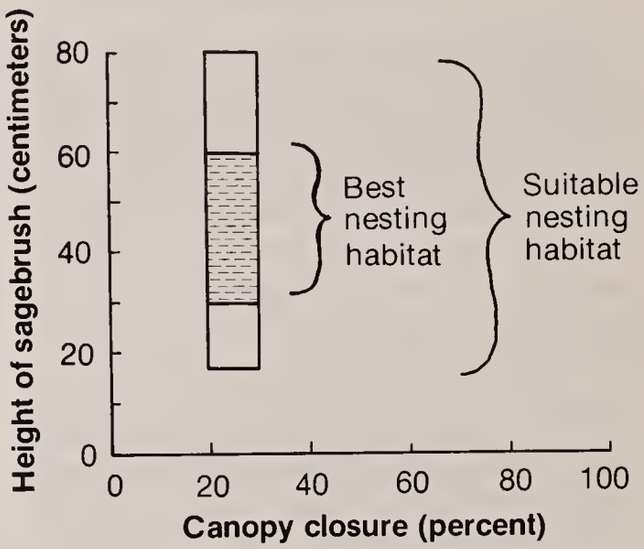

Figure 10.—The relationship of sagebrush height and percentage of canopy closure in producing suitable sage grouse nesting habitat.

Table 1—Average sagebrush height used for nesting cover

State	Average sagebrush height used for nesting		Average sagebrush height in immediate area		Authority
	Centimeters	Inches	Centimeters	Inches	
Oregon	48	19			Nelson (1955)
Wyoming	25.4-50.8	10-20			Patterson (1952)
Montana	40.4	15.9			Wallestad (1975)
Idaho	57-80	22.4-31.5	23-79	9-31	Autenrieth (1981)
Colorado	52.3	20.6	32.3	12.7	Peterson (1980)
Utah:					
Reseeded	29.2	11.5			Trueblood (1954)
Not reseeded	53.3	21.0			

Brood-Rearing Habitat

Brood rearing is an important phase of grouse production. Fall population levels depend on the survival of young through the summer. This means that hens require well-sheltered areas that provide maximum protection for them while brooding. Protection of the brood from adverse weather and predation is extremely important immediately after hatching. Chicks may be killed by adverse weather (Carr 1968, Dalke et al. 1960, Griner 1939, Nelson 1955, Patterson 1952, Pyrah 1960).

Dargan and Keller (1940) attributed high mortality of chicks to predation rather than to adverse weather. Predation accounts for considerable mortality in chicks. Most egg predation and nest destruction in Oregon has been attributed to ravens (Batterson and Morse 1948, Girard 1935, Nelson 1955). Thus, protection from adverse weather (low temperatures, snow, rain, and high winds) and predation during the chicks' first weeks of life appears to be critical factors determining fall densities (Carr 1968).

Broods usually stay near the nest for several hours after hatching. Chicks begin feeding as soon as they leave the nest but are limited in mobility, so food in the form of suitable insects and forbs must be close by (Carr 1968, Girard 1935, Griner 1939, Nelson 1955).

The diet of chicks during their first week is chiefly insects, especially beetles and ants. Succulent forbs—such as common dandelion, common salsify, western yarrow, prickly lettuce, clover, aster, and phlox and shrub foliage—become more important as time passes (fig. 11). The succulence of favored foods appears to be an important factor influencing brood movements. Use of forbs depends on availability, so hens and chicks often remain in the vicinity of the nests for the first 2 or 3 weeks after hatching if insects and succulent forbs are available (Klebenow and Gray 1968, Patterson 1952, Peterson 1970a, Pyrah 1954, Savage 1969).

As plants mature and dry, grouse move to areas still supporting succulent vegetation. These may be lower elevation native meadows or irrigated meadows when no uplands with green vegetation are in the area (fig. 12). Grouse may also migrate upward, seeking habitats with succulent forbs, such as drainages at higher elevations, mountain meadows, and more mesic swales. The importance of upland meadows in some of the drier areas of southeastern Oregon cannot be overemphasized.[4] Improper livestock grazing can cause gulley erosion that results in lowered water tables, drying out of meadows, and loss of valuable feeding habitat for sage grouse.

Figure 11.—The diet of chicks the first week is insects, especially beetles and ants. Succulent forbs become important later.

Figure 12.—Wet meadows adjacent to sagebrush stands are excellent brood-rearing areas. Succulent forbs and insects, the main items in diets of young grouse, abound in wet meadows. (Photograph courtesy of Robert R. Kindschy.)

[4]D. A. Klebenow, University of Nevada, Reno, personal communication.

Further, piping water from springs to livestock troughs frequently dries up small, wet meadows that often occur around undeveloped springs (Thomas et al. 1979). In some States, roadsides and borrow pits are frequently used during June and July because of the moisture and succulent vegetation present, but roadsides in Nevada and southeastern Oregon are generally too dry for succulent vegetation to develop (Batterson and Morse 1948, Crawford 1960, Eng 1952, Gill 1965, Klebenow 1972, Nelson 1955, Patterson 1952, Rogers 1964).

A delay in maturing of forbs has a noticeable effect on bird movements. Savage (1968) noted that grouse did not use meadows one summer when the range was in good condition because succulent forbs were available elsewhere. Meadows are important, however, for three primary reasons: (1) Forbs are important in the diet of young birds and meadows are their primary source, especially in dry years; (2) free water is often found in meadows; and (3) young birds eat large numbers of ants that are commonly found associated with meadow ecotones and meadow remnants (Savage 1969).

Meadowlands or alfalfa fields are used as brood feeding sites; willows and sagebrush are used for resting and shading; and areas of sparse, low-growing sagebrush (within 3.2 km (2 mi) of the feeding areas) are preferred as night roosting areas (Griner 1939, Patterson 1952). In Montana, approximately 65 percent of all observations of grouse in August and September were recorded in bottom land types, such as alfalfa fields and black greasewood flats. Grouse may also be attracted to hay and alfalfa meadows by the overall lush vegetational aspect and not specifically to alfalfa as a food item (Wallestad 1970, 1975).

Although suitable food is important, all studies emphasize the need for cover to enhance brood-rearing. Brooding hens prefer relatively open sagebrush compared with dense stands. The percentage of canopy cover of big sagebrush at brood sites in southern Idaho was 8.5, significantly less than the average for the entire area, 14.3. Only 3 of 98 broods were found where total shrub cover was 40 to 49 percent; the rest were found where cover was less than 31 percent. Where there was an interspersion of openings mixed with dense sagebrush, broods used the more open portions. The most important variable in discriminating between habitat used by broods and that not used was the number of big sagebrush plants per 37.2 m^2(400 ft^2). Broods occupied sites with fewer big sagebrush plants than in the overall big sagebrush vegetation type (64.3 vs. 103.7 big sagebrush per 37.2 m^2 (400 ft^2)). Broods used areas where forbs were most abundant (Klebenow 1969, 1972). Broods in Montana were found where sagebrush canopy cover was less than 14 percent in June, July, and August and less than 21 percent in September (Wallestad 1971). Although large tracts of dense sagebrush seem to be undesirable brood habitat, small islands of big sagebrush, located within stands of low sagebrush, are frequently used as brood cover (Savage 1969, Wallestad 1971).

Grouse consumption of sagebrush intensifies as meadows and foliage of forbs dry and the incidence of frost increases, in late August at high elevations or in September and October in lower areas (Klebenow 1972, Savage 1969).

Hens with broods do not usually associate with other hens and broods early in summer, but as food plants desiccate, broods move to more mesic sites and begin to associate with other broods. Flocks of hens in late summer vary in size from several broods to several hundred sage grouse. These associations may be the initiation of fall and winter hen flocks (Wallestad 1975).

Wintering Habitat

As snow begins to accumulate on their summer-fall ranges, sage grouse start moving to lowlands or other sites, such as windblown ridges, where their needs for forage and cover can be met throughout the winter. The extent of seasonal movements varies with the severity of winter weather, topography, and vegetative cover. Sedentary populations meet all their seasonal requirements in the same general area and, as winter approaches, simply change their use areas from meadows to sagebrush, because they live almost entirely on the leaves of sagebrush in winter (Bean 1941, Beck 1975, Patterson 1952, Wallestad 1975). Other populations

are migratory and move 24 to 32 km (15 to 20 mi) from nesting to wintering areas in Colorado (Rogers 1964), 48 to 80 km (30 to 50 mi) on the Snake River Plains in Idaho (Dalke et al. 1963), and 80 to 160 km (50 to 100 mi) in Eden Valley, Wyoming (Patterson 1952). In eastern Montana, on the other hand, movements farther than 16 km (10 mi) are uncommon (Wallestad 1975).

In seeking wintering areas, grouse initially select areas with the most palatable sagebrush; if those areas become covered with snow, they shift to available sagebrush (figs. 13 and 14). Although wintering areas may be selected primarily on the basis of the amount of snow rather than the affinity of grouse for a particular site, the forage quality of sagebrush (chemical composition) may influence which areas are used. Wintering flocks in Idaho concentrate where low sagebrush or black sagebrush occurs. They may remain on areas supporting black sagebrush until snow covers the plants and return when the plants are again available (Autenrieth 1981, Beck 1977, Call 1979, Crawford 1960, Dalke et al. 1963, Pyrah 1954). Black sagebrush in Oregon occurs primarily in southern Malheur, Harney, and Lake Counties (Dealy et al. 1981) and is probably used as winter forage where available.

Other plant communities are also used by sage grouse in southeastern Oregon (fig. 11). Low sagebrush/bunchgrass communities typically occur adjacent to or intermixed with big sagebrush communities but are distinctly separate stands associated with shallow, stony soils (fig. 15). Cleftleaf sagebrush/bunchgrass communities occur in similar situations. Threetip sagebrush occurs in Baker and northern Harney Counties and occasionally in Malheur County. Usually found adjacent to mountain big sagebrush, threetip sagebrush retains its integrity and is used by sage grouse where available (Dealy et al. 1981).

Wyoming big sagebrush is the most common sagebrush throughout the high desert in Oregon. It is more common at elevations less than 1830 m (6,000 ft) and on more xeric mountain sites than other big sagebrush communities (Winward 1980). Sage grouse use it for winter cover and forage and for loafing and nesting

Figure 13.—In winter, sage grouse seek areas where palatable sagebrush is available as forage. The grouse will migrate to find such areas. (Oregon Department of Fish and Wildlife photograph by Vic Masson.)

Figure 14.—Stands of low sagebrush are excellent habitat for sage grouse, especially during spring, summer, and fall. Low sagebrush is also used as winter habitat where snow cover permits. (Photograph courtesy of Robert R. Kindschy.)

Figure 15.—Sage grouse winter habitat with sufficiently dense sagebrush to provide ample forage and cover.

cover where it meets the criteria for canopy cover and density.

Basin big sagebrush extends from the southern end of the Blue Mountains in northeastern Oregon and throughout the central and southeastern portions of the State. The land area occupied by basin big sagebrush constitutes a minor portion of the sagebrush complex in Oregon; much of its former range is now cultivated land. It provides good cover but poor forage.

Bolander silver sagebrush and mountain silver sagebrush/bunchgrass communities are found in seasonally moist areas in central and eastern Oregon. The two subspecies are associated with two distinct habitats, closed basins and streamside or pond-edge meadows. The basin subspecies, Bolander silver sagebrush, is distributed within the desert areas of Oregon from Prineville throughout the southeastern third of the State; the streamside-meadow subspecies, mountain silver sagebrush, is most common in east-central and southeastern Oregon where there are seasonally high water tables adjacent to streams and meadows (Winward 1980). Bolander silver sagebrush typically has a sparse understory and is poor brooding habitat, but both subspecies of silver sagebrush are palatable and are used by sage grouse for cover and winter food (Dealy et al. 1981). The different subspecies in Oregon vary considerably in palatability and plant structure. Even though they may look similar, some sagebrush ranges are much more important to sage grouse than others.

Habitat surveys conducted during the summer may give the impression of vast acreages of sagebrush available as winter range for grouse. Observations during winter, however, reveal that much of the habitat is not available because of snow depth or it is unsuitable for other reasons. For example, when snow depth in Montana exceeded 30.5 cm (12 in), sage grouse were restricted to taller sagebrush stands. Only 7 percent of the range was available when snow depth exceeded 30 cm (11.8 in) (Wallestad 1975). Sage grouse in Idaho moved to taller sagebrush types when snow depth reached about 33 cm (13 in) (Bean 1941).

Areas of greatest available canopy cover tend to be most used (Autenrieth 1981, Eng and Schladweiler 1972). Winter ranges in eastern Montana have little if any slope and are large expanses of dense (20 percent or greater canopy cover) sagebrush with an average height of 25.4 cm (10 in) (Eng and Schladweiler 1972). Grouse in Colorado used areas of less than 15 percent slope and preferred southwest exposures in winter (Beck 1975, Beck and Braun 1978). This association with dense stands of sagebrush usually begins in September and continues through the breeding and nesting seasons. In fact, 15 percent canopy cover of sagebrush appears to be the minimum acceptable for sage grouse winter and nesting habitat (Wallestad 1971, 1975; Wallestad and Schladweiler 1974).

Flocks may segregate by sex in the winter when females use denser stands of sagebrush than do males. Sagebrush density (determined for brush exposed above the snow) averaged from 46.0 to 63.7 plants/0.004 ha (0.001 acre) for males in two winters and 68.2 to 77.5 plants/0.004 ha for females (Beck 1977). The maximum may be about 49.6 plants/0.004 ha with an average height of 55.8 cm (22 in) and a canopy cover of 38.1 percent (Autenrieth 1981).

Winter is usually the critical period of the year for most wildlife and the most taxing on their physiological systems, but if the grouse have adequate and suitable sagebrush, they usually emerge from winter in good physical condition. Yearling and adult males and females even gained weight in late winter (January-March) in North Park, Colorado (Beck and Braun 1978).

Animal

PREDATION

Losses of sage grouse nests and young to predation are often high and are probably the most significant factor in determining annual recruitment to the population (Allred 1942, Autenrieth 1981, Batterson and Morse 1948, Gill 1964, Patterson 1950). For example, one study in Oregon in which 66 of 131 nests were destroyed by predators showed that the greatest single limiting factor of sage grouse was

nest predation by ravens (Batterson and Morse 1948). Ravens were also the only significant avian predator on sage grouse nests on Autenrieth's (1981) south-central Idaho study area. In other areas, magpies may be important nest predators (Brooks 1930). According to Gill (1965), hens are only present on the nest while actually laying eggs during the 10- to 14-day laying period. They are commonly absent from nests from one-half hour after sunrise to 1 hour before sunset, and nests are highly vulnerable to predators.

Crows also prey on young grouse (Grondahl 1956). But predation by crows is reduced when the grasses and forbs begin to grow and conceal the nests better. In addition, other food items, such as insects, become more plentiful as vegetation develops, and crows shift their feeding to those sources, which reduces their efforts to locate unattended nests. Avian predators have more difficulty finding nests that are concealed by vegetation. Terrestrial predators may find nests more by smell or by accident than by sight, and good cover probably makes their efforts to find nests less successful. Where badgers were abundant in Oregon, Nelson (1955) found that they were an important predator of sage grouse nests, and Gill (1965) found that badgers and Richardson ground squirrels in Colorado were efficient predators of sage grouse eggs. The Richardson ground squirrel may also be an important predator on young sage grouse (Keller et al. 1941).

Management Relationships

The effects of sagebrush removal and/or modification on a population of sage grouse can be evaluated by the following: (1) presence or absence of grouse on treated areas and the relative use of the areas by birds as indicated by dropping counts, (2) changes in population levels as indicated by numbers of strutting males on all leks, and (3) direct observation of birds on and around the treated areas (Wallestad 1975).

EFFECTS ON BREEDING ACTIVITIES

Sagebrush control may increase or decrease the desirability of leks, depending on circumstances. Although openings in sagebrush habitat may be created by killing the shrubs, increased grass density may prevent the openings from being used (Carr 1968). One of the best documented instances of the detrimental effects of sagebrush removal on sage grouse involved an isolated population in Meagher County, Montana. Five leks were eliminated as a result of sagebrush being sprayed and 49 percent (4781 ha or 11,808 acres) of available sagebrush types being converted to cropland (Peterson 1970b). One lek averaged 54 males during 13 breeding seasons. Within 2 years after it was sprayed only three males used it, and it was then totally abandoned (Peterson 1970b).

A 4858-ha (12,000-acre) sagebrush spray project in Wyoming was responsible for the elimination of sage grouse from a winter range that supported 1,000 birds prior to treatment. Four leks on the treated area declined from a total population of 50 males to none 4 years after treatment with 2,4-D (2,4-dichlorophenoxyacetic acid). Eight years after treatment, the leks had a total of 31 males. Adjacent grounds in unsprayed areas had only minor fluctuations in numbers of birds during this same period (Higby 1969). Complete block spraying of an area surrounding a large lek in Colorado resulted in almost complete abandonment of the lek within 7 years of spraying (Braun and Beck 1976).

Wallestad (1975 p. 37-39) observed that:

> Treatment of 751 acres (24 percent of the total suitable habitat adjacent to the King Ranch Strutting Ground) resulted in a 50 percent reduction in cocks the following year. However, 3 years post-treatment the population had recovered to pretreatment levels. Spraying of 640 acres (11 percent reduction in suitable habitat) resulted in no significant post-treatment population change on the adjacent South Pike Creek Strutting Ground. A new ground (possibly because of spraying) was established 1.5 miles to the northeast, the

year following treatment. Two hundred fifty-three acres adjacent to the Highway Strutting Ground was scheduled for a partial kill of sagebrush (65 percent reduction in crown coverage); however, the small size of the area, combined with a light actual kill (25 percent reduction in coverage) produced no major effect on the strutting ground cock population.

Of the 1,090 acres of sagebrush sprayed adjacent to the North Yellow Water Strutting Ground, 839 acres (31 percent of the total suitable habitat) had a canopy coverage exceeding 15 percent prior to treatment. The sprayed area was also the largest block of continuous habitat in the area. In the two post-treatment years there was a 63 percent loss in cocks on the strutting ground while other grounds remained relatively stable.

Total numbers of male sage grouse on 3 leks within 0.5 miles of the treated area increased an average of 28 percent from pre- to post-treatment years. In the face of an increasing population, it appeared that sagebrush treatment had no effect on the sage grouse population. When compared to control leks in the same population, however, the effect became more pronounced. Total numbers of males on two grounds further than 2 miles from treated areas increased an average of 323 percent during the same period. Number of sage grouse observed on grounds within 0.5 miles of treated areas and those further than 2 miles led to the conclusion that differences were related to sagebrush spraying.

The effects of sagebrush removal on use of leks probably varies in different areas, depending on many factors, but evidence indicates that the results can be disastrous to some populations. Impacts seem to relate mostly to the amount of food and cover remaining within approximately 1.6 km (1 mi) of the leks.

EFFECTS ON NESTING HABITAT

Cover and food are important habitat requirements in nesting areas. Nesting commences in early spring before many plants have started growing, so sagebrush serves as the primary source of food during this period. From this standpoint, sagebrush control could eliminate nesting in an area by eliminating the hens' food supply. Grouse ceased nesting on newly sprayed areas with less than 5 percent live sagebrush canopy cover, and nesting was nearly nonexistent in older sprayed areas with about 5 percent live sagebrush cover. Broods were less affected by herbicide treatment, however, and they continued to use some sprayed areas (Carr 1968, Klebenow 1970).

Where sage grouse have been observed in areas with a strip-spray pattern, the majority were within 23 to 29 m (75 to 95 ft) of unsprayed strips. They apparently preferred unsprayed sagebrush sites, or sites with similar canopy cover, to treated areas (Martin 1965).

Sagebrush control with 2,4-D usually reduces the quality of nesting cover and nesting density, but dead sagebrush stalks and increased grass understory normally provide cover for a few years that partially offsets the loss of living sagebrush. The greatest limitation imposed on nesting distribution by control of sagebrush would be the elimination of food required by the incubating hens. Unlike plowing and reseeding, which tend to increase the amount and variety of forbs, 2,4-D tends to reduce forbs and sagebrush. Thus, alternative foods that could supplement sagebrush in the diet, at least toward the end of incubation, might also be reduced (Carr 1968).

Although nests may be found under dead sagebrush, protection and concealment are less than under live sagebrush. Consequently, desertion and destruction of nests in such circumstances are greater.

Trueblood (1954) compared seeded, reseeded, and nonreseeded areas and found that nesting density, nesting success, and hatching success were lower on plowed and reseeded areas. Reseeded lands produced one nest for every 9.5 ha (23.5 acres) and nonreseeded lands one nest per

7.8 ha (19.2 acres). The average height of nesting cover on reseeded lands was 29.2 cm (11.5 in) and 53.3 cm (21 in) on areas not reseeded. No nests were found more than 228.7 m (250 yd) from water. Hens nesting in reseeded areas preferred scattered remnants of sagebrush cover, but more than one-fourth of the nests were found beneath clumps of grass. Although nesting suitability was closely related to precipitation on reseeded ranges, it was relatively independent of precipitation on ranges not reseeded. Nesting hens were more easily detected by observers on reseeded areas than on areas not reseeded.

EFFECTS ON BROOD-REARING AND SUMMER HABITAT

The effects of sagebrush control on brood-rearing and summer areas seem to depend mainly on: (1) forb and grass production subsequent to treatment and (2) the amount of sagebrush retained for cover.

A reduction in cover of sagebrush caused by spraying can reduce the brood-carrying capacity of an area. Old sprayed areas where sagebrush and forbs have regrown since the original treatment may be used by broods, but not the more recently sprayed areas with high sagebrush kills (Klebenow 1970, Martin 1970, Rogers 1964).

Autenrieth (1969) conducted a 3-year study in Idaho after a 1965 spray project and concluded that spraying strips in a relatively high precipitation area (33 cm (13 in) annual precipitation) may benefit brood-rearing habitat because of a quick recovery of important forbs, such as dandelion and western yarrow. After 3 years, the average cover of dandelions in the spray strips was 17.2 percent compared with 11.2 percent in the leave strips. The leave strips were used by broods for feeding and occasional roosting. Because of the relatively high elevation (1784 m or 5,851 ft) and annual precipitation, a mountain meadow effect was created by strip spraying. Most sage grouse habitat occurs at low elevations with one-half (or less) the annual precipitation of the Idaho study area; in such areas eradication of sagebrush is usually detrimental to grouse populations (Braun et al. 1977).

Total forb cover is not as important to sage grouse as cover of highly preferred species of forbs. Sagebrush control with 2,4-D reduces most forbs and makes sprayed areas less suitable for summer feeding (Autenrieth 1970, Braun and Beck 1976, Carr 1968, Klebenow and Gray 1968, Martin 1970, Peterson 1970a). Many insects eaten by young sage grouse are killed by the 2,4-D ester used with an oil carrier (Hanson 1952).

In many areas, streams flow through sagebrush-covered valleys and along draws in rolling hills. Meadowlike openings that can be created adjacent to streams by spraying or plowing the sagebrush could be beneficial to sage grouse broods, provided livestock are not permitted heavy early grazing in these areas. Livestock tend to concentrate on meadows, however, and to graze them so heavily that sheet erosion or gully erosion begins. Such intensive use of small meadows will render them of little value to grouse (Oakleaf 1971).

EFFECTS ON WINTER HABITAT

The effect of sagebrush control on sage grouse in winter depends mainly on the extent of sagebrush kill. Because sagebrush is practically the only food eaten by grouse in winter (Carr 1968, Patterson 1952, Wallestad 1975), the grouse will be forced to abandon areas where adequate food and associated cover are no longer present (fig. 16).

Figure 16.—This valley was converted from sagebrush to crested wheatgrass. Although increased grass production in some areas will reduce livestock grazing in adjacent sagebrush stands, the treated areas will be of little value to grouse. Evaluation of overall impacts on sage grouse should be made before sagebrush ranges are converted to grasslands.

Wintering areas hold some of the highest densities of sage grouse, and they may be used on an annual basis by birds from several leks. Such areas may be the primary habitat for 7 to 8 months of the year and may have considerable influence on grouse distribution over a wide area (Eng and Schladweiler 1972). Wallestad (1975) further stressed the importance of such areas by linking them with spring habitat and calling them wintering-nesting complexes. Thus, a sage grouse population may be more sensitive to the loss of wintering areas, which sometimes incorporate the breeding-nesting complex, than to the loss of habitat used during summer and fall (Eng et al. 1979).

Winter use of sagebrush control areas by grouse is proportional to the severity of treatment. Treatments that kill the smallest percentage of sagebrush affect grouse use the least, and the duration of the adverse effect is shortest. For example, Pyrah (1972) determined that herbicide applied in strips that killed only a part of the sagebrush sprayed, block partial kill, mechanical treatments, and total kill spray (in that order) were increasingly detrimental to grouse. Virtually no winter use occurred in areas of total sagebrush kill. Higby (1969) studied an area in Wyoming where more than 80 percent of the sagebrush cover was destroyed over a 5-year period in a 4858-ha (12,000-acre) treatment project. Prior to treatment the area supported approximately 1,000 birds in winter, but there was practically no winter use on the area during the 5-year post-treatment study.

EFFECTS OF FIRE ON GROUSE HABITAT

Wildfires are natural with effects that vary depending on areas burned and intensity of the fire. At times, hot wildfires destroy important wintering areas for sage grouse.

A fire in the right place, at the right time, and of the correct size and intensity can create an opening that birds may use as a lek. Such openings, 0.4 to 4 ha (1 to 10 acres) in size at the elevations used for breeding, may be beneficial to grouse in homogeneous sagebrush habitats (Dalke et al. 1963, Klebenow 1972, Schlatterer 1960).

Sage grouse prefer light to moderate sagebrush density for nesting. Where sagebrush is dense (in excess of 20 to 40 percent canopy cover) and greater than 61 cm (2 ft) in height, controlled burning to achieve a mosaic of sagebrush and grassland with a variety of sagebrush heights would probably be beneficial to the birds (fig. 17). Repeated burning could be adverse in this case, as would large, hot fires that removed an excessive amount of cover (fig. 18). Where cover is already limited, fires could cause adverse conditions for the grouse (Griner 1939, Pyrah 1963).

Figure 17.—Fires that create mosaic patterns in dense sagebrush stands and that leave sagebrush plants scattered throughout the burn create openings that are beneficial to sage grouse.

Figure 18.—A hot fire almost completely eliminated sagebrush from this large area and destroyed the area as sage grouse habitat.

Diversity of habitat types, both in terms of food and cover, should be the objective. Planned fire can produce favorable openings and higher yields of forbs for grouse in summer habitat (Blaisdell 1953). But fire is not desirable in winter habitats because retention of sagebrush is essential on winter ranges. Even tall, decadent sagebrush, not useful for nesting or brooding, may be important during severe winters when most other sagebrush could be covered by snow (Call 1979).

Fires are both beneficial and detrimental to sage grouse habitat, depending on the particular area and situation. Vegetation is a dynamic resource, and sage grouse needs are best met with a mixture of successional stages and plant species composition that *always* includes sagebrush. Such conditions have been accidentally achieved by wildfires and can be achieved intentionally with wise planning.

Animal Management

EFFECTS OF LIVESTOCK GRAZING

There are three primary effects of livestock grazing on sage grouse habitat: (1) changes in composition, density, and structure of vegetation; (2) disturbance of nesting hens and possible trampling of nests; and (3) removal of brood forage and cover in meadows.

Many sagebrush ranges on public lands are grazed by cattle in late spring, summer, fall, and winter and by domestic sheep in winter. Spring and early summer grazing by livestock removes a high percentage of grass and forbs at the time when sage grouse are turning to forbs as their primary forage. The presence of succulent forbs in brood-rearing areas is highly important to young sage grouse. Although the dependence of newly hatched chicks on insects is high, by the time they are 4 to 8 weeks old their diet consists of about 75 percent forbs and 15 percent sagebrush leaves (Savage 1969). Therefore, rapid removal of forbs by livestock on spring and summer ranges may have a substantial adverse impact on young grouse, especially where forbs are already scarce. By May, adult grouse also shift from diets dominated by sagebrush to diets dominated by forbs.

Grazing domestic sheep on sagebrush ranges is a common practice in winter. In some areas sagebrush has been grazed so heavily in consecutive winters that the brush has been severely damaged. If such use occurs on important sage grouse wintering areas, the grouse may have difficulty obtaining sufficient forage for their needs, especially during severe winters with deep snow (Call 1979). The degree of impact therefore varies with the time and intensity of grazing and the severity of the winters.

Forced movement of cattle and sheep across rangelands is commonly practiced, particularly in spring and fall. There may be significant impacts on nesting hens and young broods caught in the paths of such drives in the spring. Nests are known to have been deserted because of disturbance by sheep and cattle (Autenrieth 1981, Rasmussen and Griner 1938). In fact, grazing by sheep is much more detrimental to a sage grouse nesting area than is grazing by cattle (Girard 1937).

On two occasions bands of sheep were noted to have caused hens to flush and simultaneously to flip eggs out of their nests. Sheep subsequently stepped on these eggs, destroying them, and the nests were deserted in both cases (Patterson 1952). Sheep have also destroyed nests by stepping into them. In a few cases, nests were placed on open ground between shrubs and could have been destroyed by livestock activities, but no such destruction was recorded. There is no indication that livestock are a serious factor in destruction of nests, although desertion of nests because of livestock activities is frequent under certain conditions.

Desertion of nests by sage grouse is most prevalent in the vicinity of sheep bed-grounds. Bands of 2,000 to 3,000 sheep seriously disturb nesting activities. Patterson (1952) noted that a period of nest desertion coincided with several thousand sheep that began moving into his study area en route to their summer ranges. Most deserted nests were either preincubated or in the early stages of incubation. Nests were seldom deserted, however, after incubation was well underway. During incubation, several birds were flushed from nests by sheep, but the nests were not deserted.

Hens abandon their nests with little provocation during the egg-laying period (mid-April through early May). Yearling hens are prone to abandon their nests even when disturbed during incubation. The impact of a livestock drive could, therefore, be great because yearling hens are usually the largest reproductive age class. It is therefore best to avoid known nesting areas (within 3.2 km (2 mi) radius of leks) from mid-April to early June to reduce abandonment of nests by sage grouse (Autenrieth 1981).

Upland meadows have seriously deteriorated because of excessive livestock grazing on public lands in Nevada (Oakleaf 1971), Oregon, and other Western States. Sage grouse use in these areas has decreased because of the diminished food supply (fig. 19). Meadows provide a source of food, especially forbs, and water that is usually absent or not available on adjacent, more xeric rangelands (Savage 1969). Spring-fall and "season long" grazing have caused a marked deterioration in meadows with related gully cutting and lowering of the water table. This situation may be one of the most severe negative impacts on sage grouse in the Great Basin. Although excessive livestock grazing will cause upland meadows to gradually deteriorate, light grazing may produce benefits to grouse. Sage grouse are attracted to the green regrowth of aster, yarrow, and common dandelion on grazed meadows. The regrowth is more succulent and contains more crude protein and less fiber than ungrazed forage (see footnote 4, p. 9).

Mesic sites, such as stream bottoms, are usually heavily grazed by cattle before they seek forage on less accessible, rougher terrain (fig. 20). This is also true on upland meadows. It is difficult, expensive, and usually controversial to establish a livestock management system that will protect upland or streamside meadows. Autenrieth (1981) suggested, however, that one technique for protecting meadow forbs from livestock trampling and grazing is to fence the streamside meadow and leave access gaps for water. Even with this costly system, grazing may be allowed only once every 3 years on meadows if precipitation does not exceed 18 to 23 cm (7.1 to 9.1 in) per year. If precipitation approaches 30 cm (11.8 in) per year, he suggested grazing might be permitted in August when young birds have become mobile.

Figure 19.—Upland meadows in sagebrush stands are important to sage grouse broods. Intensive livestock grazing has caused serious deterioration of these meadows.

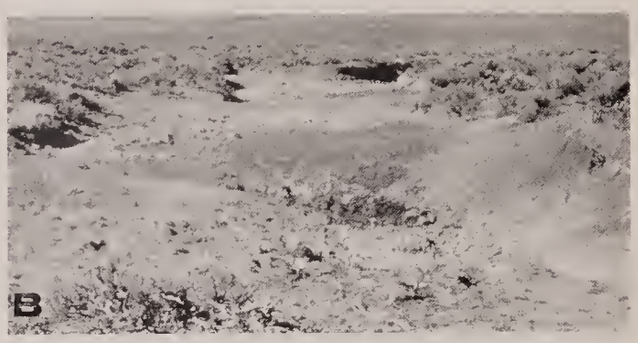

Figure 20.—Mesic habitats along stream bottoms usually receive intensive grazing by livestock (A). Such heavy grazing in spring and early summer removes most of the forbs preferred by sage grouse (B).

EFFECTS OF HUMAN DISTURBANCE

Human activities in sage grouse habitat cause degrees of disturbance. Such activities vary from occasional harassment to disruption of the nesting cycle to elimination of use on critical winter ranges.

Daily human disturbances on sage grouse leks could cause reduction in mating, and some reduction in total production. If flushed, grouse usually fly from the strutting ground and do not return again that day. Some leks are known to the public and are visited by photographers and other interested persons to watch the annual courtship rituals. Such activities need to be curtailed if they disrupt mating. Grouse are tolerant of automobiles and may be watched from fairly close range if the observers do not leave their vehicles. But the instant a person leaves a vehicle the grouse become alarmed and generally take flight, not to return again until the next day. Fortunately, the mating season is fairly long (up to 2 months) so receptive hens will usually be mated.

Off-road vehicles occasionally run over a nest, but the amount of loss is probably insignificant. Organized motorcycle or four-wheel drive races across sage grouse nesting habitat, however, can cause substantial loss of production from direct destruction of nests, from abandonment of nests during egg-laying, from destruction of young chicks, or from all three. If sage grouse production is a management goal, then it is wise to postpone such races until after the first of September when the birds are old enough to fly out of harm's way.

There is also much exploration for oil and gas in some States. The effects of these activities on sage grouse and their habitat is poorly known and needs further evaluation.

Management Tips

Where sage grouse are to be managed as a featured species, their primary habitat requirements need to be identified and their habitat maintained or enhanced to meet those needs. The following management tips (adapted from Autenrieth et al. 1982, Braun et al. 1977) are designed to help a manager achieve this goal.

VEGETATION MANAGEMENT

Habitat management, which is largely sagebrush and forb management in the case of sage grouse, is critical to the perpetuation of grouse populations. Sagebrush-grassland ranges will continue to be altered, whether by design, by accident, or by natural succession. Planned modifications could include chemical control, chaining, plowing, beating, disking, and burning, with or without reseeding. Some project considerations for controlling sagebrush that will protect important grouse values are:

1. The Federal land management agency and the State wildlife agency should coordinate closely in planning sagebrush treatment projects. A minimum of four seasons is needed to gather data on grouse use of the area prior to preparing final project plans. Areas determined to be important for nesting, brood-rearing, or wintering should not be disturbed until, and unless, the treated sagebrush areas become suitable habitat for meeting these needs.

2. Project plans for sagebrush control should include provisions for long-term quantitative and qualitative measurements of vegetation before and after treatment. This will provide information on effects on grouse habitat and populations that will be valuable in planning further projects. The land managing agency could take the responsibility for evaluating the project as it relates to changes in habitat, and the wildlife agency could assume responsibility for measuring effects of the project on sage grouse and other wildlife.

3. No control work should be considered where live sagebrush cover is less than 20 percent, or on steep (20 percent or more gradient) upper slopes with skeletal soils where big sagebrush is 30 cm (12 in) or less in height.

4. Whenever sagebrush control is determined to be desirable in sage grouse habitat, for whatever reasons, less damage to sage grouse populations will occur with either (1) partial kill, whether by spraying, chaining, plowing, or other means; or (2) creation of strip patterns or mosaics (fig. 21). Partial kill leaves sagebrush and forbs essential for grouse survival and still permits substantial increase in grass production for livestock. It also helps to retain snow and moisture longer in the spring, which creates better growing conditions for forbs and grasses later in the season.

Figure 21.—Sagebrush treatment projects can be designed to produce benefits for livestock while maintaining adequate habitat for sage grouse. This project involved the strip spraying method. (Photograph courtesy of Robert R. Kindschy.)

In strip patterns, the widths of treated and untreated areas can vary for the convenience of the application technique, but treated areas should be a maximum of 30 m (100 ft) in width, and untreated areas need to be at least as wide as treated areas. Alternate strip sagebrush removal or spraying generally has little effect on sage grouse, especially where only partial kill (less than 60 percent) is involved. In creating mosaic patterns, the treated areas should be no more than 274 m (300 yd) in circumference with similar size areas of untreated brush interspersed between the treated areas. The untreated areas can be manipulated when food and cover plants in the treated areas attain composition (or value to grouse) comparable to that of the untreated areas.

5. Treatment of sagebrush is detrimental to sage grouse if undertaken within the breeding complex. No sagebrush control should be done within approximately 3 km (2 mi) of a lek. All areas to be protected from treatment need to be clearly defined on the project maps, and close supervision is critical.

6. Streamsides, meadows, and secondary drainages (dry or intermittent) need to retain their integrity. A minimum of 100 m (330 ft) of living sagebrush should be retained adjacent to the edges of meadows and drainages to provide essential cover for broods and adult birds that use these areas for foraging. Onsite inspections will enable biologists to assess the desirability of increasing the width of untreated strips in specific areas. Erosion along drainages has frequently been increased by excessive livestock grazing and trampling. Consequently, water tables have been lowered, which causes an increase in xeric species. Methods should be devised to raise water tables, decrease erosion, and increase mesic species that will benefit grouse and stabilize the watershed.

7. Sagebrush should not be treated in areas known to have supported wintering populations of sage grouse over the years. Periodic winter observations will enable biologists to determine the critical areas to be protected for survival of grouse.

8. Spraying should be done with either a helicopter or ground equipment to obtain precise application. Spray should be applied when wind velocity is less than 10 km (6 to 7 mi) per hour.

Chemicals other than 2,4-D should be considered for control of sagebrush. The loss of forbs on sage grouse range is one of the serious problems in spraying with 2,4-D. The phenological development of forbs is critical and must be evaluated carefully before treatment. Carpenter (1974) tested applications of 2,4-D on varying amounts of snow cover. As snow cover diminished, forb loss increased. For example, an application in Middle Park, Colorado, on April 4 killed 26 percent of the sagebrush with no forb mortality. An April 17 application killed 63 percent of the brush and 17 percent of the forbs.

Round-Up applied to sagebrush in winter will kill only vegetation protruding above the snow (Autenrieth 1981).[5] It kills all plants on contact, but forbs are dormant and are frequently covered by snow during this period. So the herbicide should have no effect on them.

Chaining sagebrush (pulling a 90-120-m (98-131-yd) ship's anchor chain between two crawler tractors) is one mechanical method of

[5]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

destroying sagebrush by breaking off the woody portions or tearing up the entire plant. In this method the tractor operators can exercise precise control over areas treated and can produce any type of treatment patterns desired. The amount of brush removed can also be controlled; that is, some areas are chained twice to increase the amount of sagebrush killed.

Plowing of sagebrush with a crawler tractor will kill a high percentage of the brush. This method may be used where sagebrush is too low for chaining to be effective and the understory is not adequate to carry a controlled burn. Seeding of forbs and grasses will be necessary after plowing.

LIVESTOCK MANAGEMENT

1. Livestock grazing, primarily by cattle and sheep, is the dominant use of public rangelands. Where sage grouse are to be a featured species, it is paramount that only light grazing be permitted on important sage grouse wintering areas. Heavy grazing (in excess of 50 percent of current year's growth) may leave inadequate forage for grouse and will gradually cause a decline of sagebrush in the plant species composition. Light grazing (less than 30 percent of current year's growth) may benefit grouse in deep snow conditions by uncovering sagebrush plants, making them more available for use by grouse. Grazing by all ungulates will need to be monitored to ensure that sagebrush on the important wintering areas is not permitted to deteriorate.

2. Grazing domestic sheep on sage grouse nesting areas is best delayed until about the 1st week in June, or until the young grouse have hatched. Domestic sheep may cause considerable abandonment of nests by sage grouse around sheep bed-grounds, trailing areas, and feeding areas (Autenrieth 1981, Patterson 1952, Rasmussen and Griner 1938). Sheepherders can be instructed to bypass or otherwise avoid identified prime nesting areas when trailing sheep from winter to summer ranges.

3. Cattle do not commonly cause abandonment of nests or trampling of nests and may be grazed during any season as long as sagebrush and forb components do not deteriorate as a result of such activity.

4. Grazing management may be used to help create the plant structure and composition desired for sage grouse—manage the sagebrush for an average height of 30 to 80 cm (12 to 31 in) and an average composition of 20 to 30 percent. Good grouse habitat should have from 5,000 to 10,000 sagebrush plants per 0.4 ha (1 acre).

5. Livestock grazing of sagebrush ranges during years of unusually low precipitation and poor plant growth will cause an earlier than normal removal of grasses and forbs. This can have a serious impact on grouse dependent on forbs in that locality. In important sage grouse nesting and summering areas, livestock grazing should be monitored to protect at least 50 percent of the annual herbaceous vegetation (by weight) prior to mid-September. After mid-September, grouse commence feeding on sagebrush and increased livestock grazing on herbaceous vegetation will not be detrimental.

WATER DEVELOPMENT

Grouse concentrate around water sources in late summer and fall when forbs have desiccated. This suggests that grouse habitat can be improved by providing water near meadows or other good forb-producing areas, or by managing water for livestock so that water is available to grouse throughout the summer and fall. It is probably preferable to provide such water at ground level, such as from a water tank overflow, or by constructing small rocky pools with concrete bottoms, but any water that can be reached will be used (fig. 22).

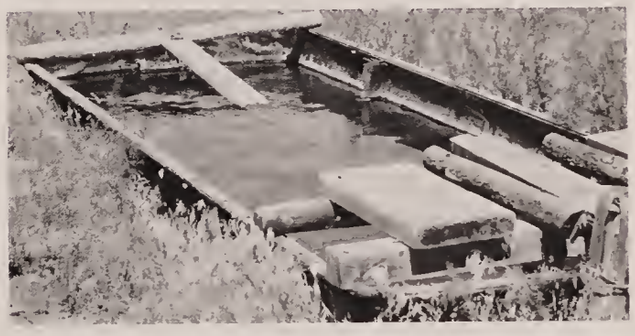

Figure 22.—Livestock water troughs are commonly used by sage grouse. Ramps for birds should be installed in all water troughs. Surplus water should be permitted to overflow onto the ground for use by all forms of wildlife.

It is best to fence springs in brood-rearing areas and to pipe water for livestock to an outside stock tank with a float valve system. When the tank is full, water can be allowed to run out of the spring and across the fenced meadow to stimulate production of forbs and grasses (Thomas et al. 1979).

It is good to fence reservoirs and to pipe water to an outside trough. Storing water in the reservoir will ensure availability of water for grouse and other wildlife in late summer.

Guzzlers can be installed on sage grouse summer range where free water is limited in quantity or is erratically available. Grouse will use water on a daily basis by late summer. A wide variety of guzzlers and water developments can be constructed to suit the needs in a given circumstance. Guzzler designs have been reviewed by Wilson (1977) and Roberts (1977).

FENCING

Barbed wire fences kill many large birds, especially when the fences are located in swales and on ridge lines where flying birds come on them unexpectedly. Owls, falcons, sage grouse, and other birds have flown into barbed wires and have been killed. At one site near Randolph, Utah, for example, a conservation officer of the Utah Division of Wildlife Resources counted approximately 36 carcasses of sage grouse along 3.2 km (2 mi) of fence in 3 winter months of the first winter the fence was in place (fig. 23). Steel posts were placed about 10 m (33 ft) apart with stays between, which made the fence somewhat inconspicuous (Call 1979). Trueblood (1954) also reported that young grouse were often killed when they flew into fences built to control cattle.

Sage grouse are bulky birds and not very maneuverable. They frequently fly low and fast across sagebrush flats, and new fences in sage grouse habitat can be deadly to birds that strike them. When a new fence is constructed in sage grouse habitat, the danger to sage grouse can be reduced by hanging colored tape or cloth strips from the top wire to make the fence more visible to flying birds.

Figure 23.—A new fence to control cattle killed at least 36 sage grouse in a 3-month period; note the sage grouse feathers. Flagging should be hung on newly constructed fences in sage grouse habitat to warn birds of the fences.

Fencing meadows can protect them against excessive livestock grazing and can provide important advantages to the grouse. Meadows used by grouse for brood-rearing can be important to the survival of young grouse, especially the first 2 months after hatching.

VISITOR AND VEHICLE MANAGEMENT

Some sage grouse leks are well known to the people of local communities who enjoy visiting them to photograph or to watch the strutting activities of the grouse. Public awareness campaigns, including notices published in local newspapers each spring, should inform interested people to remain in their automobiles and not create disturbances that cause grouse to leave the leks. Notices (signs) making the same points can also be posted along roads leading to the lek.

Of primary concern on public lands is the authorization of use of off-road vehicles (ORV) in habitats critical to sage grouse. Public land managers must continue to evaluate all potential impacts on the environment before and during such events. It may be necessary to stipulate that all such events must be conducted after the sage grouse's reproductive period, or that activities must be conducted in areas where no loss of habitat will occur.

Organizers of ORV events on public lands must be aware of the potential for fire caused by hot mufflers and tailpipes or by sparks or hot exhausts in brushy or grassy areas. Close supervision of organized events is essential to keep unexpected fires from destroying important sage grouse habitats (Call 1979).

FIRE MANAGEMENT

Fire is a natural element to which most animals have become adapted. When properly applied, fire can be successfully used in perpetuating the kinds of habitats and desired structural conditions that are essential to sage grouse (Call 1979).

Wildfires that "hot burn" winter and nesting habitat can be devastating to a sage grouse population that depended on the areas burned (Autenrieth 1981). Sagebrush should be reestablished on such areas as soon as possible by the most appropriate reseeding or resprouting methods. Reseeding, the least expensive method, should be used if suitably adapted sagebrush seed can be obtained. Stem-cutting propagation is a method that can produce new sagebrush plants in a relatively short time but may be too expensive for establishing sagebrush plants over large areas. Wallace and Romney (1972) demonstrated that big sagebrush cuttings were easy to root when succulent, vigorous material from young plants was treated with 0.3 percent indolebutyric acid and maintained in a mist chamber. Cordero and McKell (1979) tested 8- to 12-cm (3.1- to 4.7- in) cuttings of terminal and lateral twigs in experiments with Wyoming big sagebrush and mountain big sagebrush. Results indicated that cuttings obtained in winter during dormancy showed more rooting activity than those collected from growing plants.

A list to consider when fire is used as a management tool follows:

1. Fire is an inexpensive tool that may be used for habitat manipulation, but all projects must be carefully evaluated, planned, and supervised. A set of clear objectives is essential.

2. Fire is best used in a manner that results in a mosaic pattern of shrubs and open areas, where the resultant openings range in size from 0.4 to 4.0 ha (1 to 10 acres).

3. Large, hot fires may remove an excessive amount of cover or may sterilize the soil.

4. Burning within an area should be done on a rotational basis, different patches burned every few years, with as long as 20 years between burning treatments on each site. This will produce a diversity of habitats within the general area. Timing of treatments over the years will depend on sagebrush response and growth rates at the specific sites.

5. Best results from burning occur in late April and early May when dry grasses and other herbaceous fuels from the previous growing season will carry a relatively cool fire. This will leave some sagebrush and still create openings for additional growth of grasses. Fires in late spring and early summer, however, could destroy many nesting birds and other young wildlife, including sage grouse; so use of fire is preferable when young are capable of escaping. At times, it may be necessary to use prescribed fire in the spring to obtain the desired changes in habitat. Strip burns that do not exceed 45 m (50 yd) in width and 90 m (100 yd) in length create desirable openings for sage grouse (Autenrieth 1981).

6. Sagebrush habitats identified as important wintering areas that are still in vigorous condition should remain intact. Grouse depend on leaves of sagebrush in such areas, not on potential development of grass and forbs in the understory or interspersed openings. If important stands of sagebrush used by grouse for wintering have deteriorated because of such things as insects, old age, or livestock grazing, the manager should initiate measures to rejuvenate the stand by light chaining, by reduced grazing, or by other means.

7. The burning techniques used by Beardall and Sylvester (1974) have been effective on sagebrush lands where precipitation is 30 cm (11.8 in) or more. The four primary elements needed for a successful burn are: (1) wet soil; (2) windspeed in excess of 12.8 km (8 mi) per hour and gusty; (3) fine fuels of 278-320 kg (611.6-704 lb) per 0.4 ha (1 acre); and (4) no burning after spring grass growth reaches 5 cm (2 in) unless burning is to improve the forbs in the community. Prescribed burns should be conducted when plants preferred as food by sage grouse are dormant (Wright 1974).

8. Livestock concentrate on burned areas and eat the new growth, so they need to be carefully managed. Haphazard burning and heavy grazing accelerate sagebrush reinvasion, soil erosion, and loss of forage plants desirable for both livestock and grouse (Pechanec et al. 1954). Grazing use must therefore be regulated to prevent excessive reinvasion by sagebrush (more than 10,000 plants per 0.4 ha (1 acre)) and to prevent removal of more than 50 percent of the annual herbaceous growth (by weight).

9. Species of sagebrush and their value to grouse need to be identified prior to burning. Some subspecies, such as *vaseyana,* may invade an area immediately after a burn and may not be as desirable for grouse as the original species or subspecies (Harniss and Murray 1973).

CREATION OF LEKS

It has been demonstrated that new leks may be established to replace traditional leks that have been destroyed by land use activities (Eng et al. 1979, Tate et al. 1979). Establishment of new leks should be attempted after such factors as proximity of nesting, brood-rearing, and wintering areas are considered. The relationship of a new lek to wintering areas is probably the most critical factor (Eng et al. 1979). Sage grouse may move more readily to a satellite lek where at least a few birds have strutted in past years (Tate et al. 1979). See Autenrieth et al. (1981) for information about mitigating losses of habitat for sage grouse caused by mining operations and other industrial developments.

Summary

Wildlife habitat has been a byproduct of management to enhance production of livestock on most rangelands. As demands continue to grow for a greater mix of products from rangelands, it is obvious that such cliches as "good range management is good wildlife management" will no longer suffice (Maser and Thomas 1983), certainly not for sage grouse. Pressure for increased production of livestock and other amenities is accompanied by growing public concern for wildlife. Ultimately, sage grouse can benefit from range management activities, but only if their welfare is planned in advance and their habitat requirements are no longer left to chance.

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Appendix

COMMON AND SCIENTIFIC NAMES

Common name	Scientific name
SHRUBS[1]	
Basin big sagebrush	*Artemisia tridentata tridentata*
Big sagebrush	*Artemisia tridentata*
Black greasewood	*Sarcobatus vermiculatus*
Black sagebrush	*Artemisia nova*
Bolander silver sagebrush	*Artemisia cana bolanderi*
Cleftleaf sagebrush	*Artemisia arbuscula thermopola*
Low sagebrush	*Artemisia arbuscula*
Mountain big sagebrush	*Artemisia tridentata vaseyana*
Mountain silver sagebrush	*Artemisia cana viscidula*
Willow	*Salix* sp.
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*
Threetip sagebrush	*Artemisia tripartita*
GRASS	
Crested wheatgrass	*Agropyron cristatum*
FORBS	
Alfalfa	*Medicago sativa*
Aster	*Aster* sp.
Clover	*Trifolium* sp.
Common dandelion	*Taraxacum officinale*
Common salsify	*Tragopogon dubius*
Phlox	*Phlox* sp.
Prickly lettuce	*Latuca serriola*
Western yarrow	*Achillea lanulosa*

[1]From Garrison et al. (1976).

Common name	Scientific name
INSECTS	
Beetles	*Coleoptera*
Ant	*Formica* sp.
BIRDS[2]	
Common crow	*Corvus brachyrhynchos*
Falcon	*Falco* sp.
Magpie	*Pica* sp.
Great horned owl	*Bubo virginianus*
Common raven	*Corvus corax*
Sage grouse (western)	*Centrocercus urophasianus urophasianus*
Sage grouse (eastern)	*Centrocercus urophasianus phaios*
MAMMALS[3]	
Badger	*Taxidea taxus*
Domestic cattle	*Bos taurus*
Domestic sheep	*Ovis aries*
Richardson ground squirrel	*Spermophilus richardsoni*
Ground squirrel	*Spermophilus* sp.

[2]From American Ornithologists' Union (1957, 1973).

[3]From Hall (1981).

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife – if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

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Pronghorns

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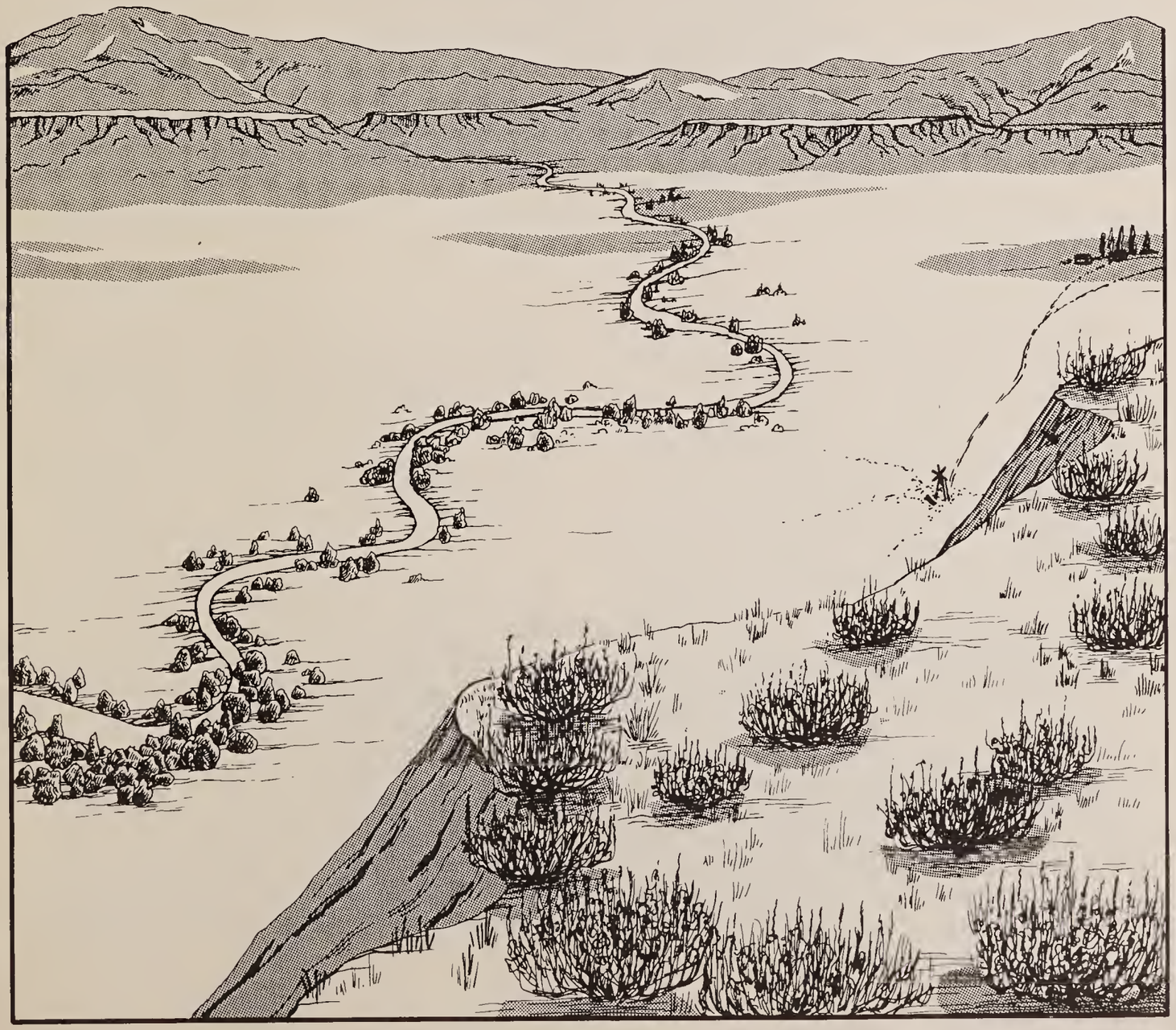
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Pronghorns

Robert R. Kindschy, Charles Sundstrom, and James D. Yoakum



SPECIAL EDITION, MARCH 1986

ABSTRACT

The sagebrush steppe of the Great Basin in southeastern Oregon is peripheral habitat for pronghorns, but the quality of the habitat can be improved through rangeland management. The relationship between pronghorns and their habitat components—the availability of water, type of forage, barriers that restrict the movement of herds, and the effect of grazing by livestock—are discussed. A worksheet is provided that can be used by range managers to rate the quality of a range as pronghorn habitat. Methods of altering habitat to benefit pronghorns are given.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon**. The purpose of the series is to provide the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the range manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands —The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Grazing by domestic livestock alters rangeland ecosystems in the Great Basin of southeastern Oregon more than any other humanly controlled activity. Such alteration, coupled with increasing human activities, produces changes that affect pronghorns (*Antilocapra americana*), sometimes called pronghorn antelope. Land managers and land use planners find it increasingly necessary to forecast and display the consequences of management activities on pronghorns.

Primary impacts on pronghorn habitat have resulted from livestock management that alters structural conditions and botanical composition of plant communities. These alterations produce distinct habitat components of differing quality.

This chapter shows the relationship between the pronghorn and its habitat in the sagebrush-grasslands of southeastern Oregon; the principles should also apply to other shrub-dominated rangelands used by pronghorns. The information can be used for both short- and long-range land use planning.

Literature review and consultation with wildlife biologists provided data that formed the framework for relating pronghorns to their habitat requirements. Where data were lacking, the best judgment of the authors prevailed.

Assumptions

The management tips provided are based on the following information or assumptions:

1. The sagebrush steppe of the Great Basin is peripheral pronghorn habitat (Yoakum 1968) (fig. 1). From reports of early explorers, we conclude that pronghorns were more abundant on the midcontinent short-grass prairies than in the Great Basin (Burroughs 1961, Fremont 1843, Thwaites 1904). Habitat components that limit populations, however, can be manipulated to benefit pronghorns (Yoakum 1978a, 1978b).

2. Pronghorns evolved to be compatible grazers with other native herbivores, especially bison (*Bison bison*)(Yoakum 1978b). Grazing by these native herbivores changed the composition of the vegetation on grassland ranges of North America to favor pronghorns.

Figure 1.—A pronghorn herd on open sagebrush steppe in Lake County, Oregon. (Photograph by James Yoakum.)

3. Forage and drinking water are the primary components of pronghorn habitat. Forage can be improved on ranges in less-than-optimum condition for pronghorns. Water distribution can be improved on some pronghorn rangelands (Yoakum 1978a).

4. Pronghorn ranges contain a variety of plant communities differing in height, composition, and forage production.

5. Pronghorn densities are influenced primarily by habitat conditions (Yoakum 1978a).

6. Favored habitats can be identified by comparing pronghorn densities between habitats (Sundstrom and others 1973).

7. Rangelands with a mixture of grasses, forbs, and shrubs of low structure provide the best pronghorn habitat (Yoakum 1972).

8. Agricultural crops other than alfalfa (*Medicago sativa*) are rarely eaten by pronghorns.

9. Fences, especially those of woven wire, frequently form barriers to pronghorn movement (U.S. Department of the Interior, Bureau of Land Management 1974).

10. The welfare of pronghorns can be enhanced by providing for their needs in range management activities (Yoakum 1978a).

Habitat Requirements

Pronghorn densities in the Great Basin average less than 0.4 per square kilometer (1.0 mi²) (Yoakum 1968). Variations in density are related to vegetation and water, which are, in turn, related to precipitation and soils (fig. 2). Yoakum (1974) described the following habitat requirements for pronghorn on sagebrush-grasslands.

ABIOTIC FACTORS

Topography

Pronghorns are adapted to low rolling topography with few slopes more than 30 percent in grade. Within such landforms, there are circumstances to which pronghorns adjust by modifying their behavior. Depending on topography, some herds do not move in response to season; some move relatively short distances with change of season and then move even longer distances in response to climatic conditions, such as increasing snow depth.

Natural Barriers

Natural barriers to movement include bodies of water, escarpments, mountains, canyons, and areas of tall shrubs or forest, sometimes accounting for isolated, unoccupied habitats that are otherwise suitable (Einarsen 1948).

Elevation

Pronghorn ranges occur from sea level to 3 353 meters (11,000 ft) but occurrence at sea level in Mexico and in alpine meadows in Oregon and Wyoming is rare (fig. 3). The largest populations, particularly in the Great Basin, are between elevations of 1 220 and 1 830 meters (4,000-6,000 ft) (Yoakum 1974).

Climate

The highest densities, which reflect the best habitats, occur where precipitation averages 25-38 centimeters (10-16 in) per year. Pronghorn in other precipitation zones do reproduce, but they maintain lower densities (Sundstrom and others 1973, Yoakum 1972).

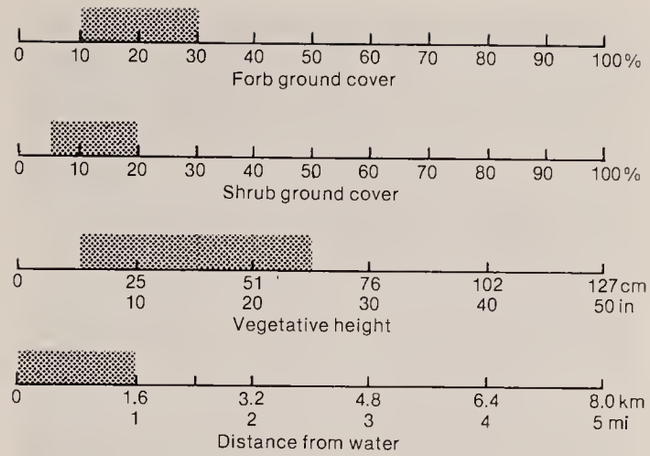

Figure 2.—Components of pronghorn habitat in the sagebrush steppe. Habitat becomes optimum when all components occur together within the bounds marked by bars.

Figure 3.—Distribution range of American pronghorns. the original range denotes only peripheral boundaries because not all areas within it were inhabited. (Adapted from Yoakum 1980).

Whenever Great Basin ranges receive a snow accumulation over 25 to 30 centimeters (10 to 12 in), pronghorns have difficulty obtaining forage. Prolonged periods of such snows are detrimental when one or more of the following occur: low quantity or quality of forage, high winds, and barriers to movement (Bruns 1977, Riddle and Oakley 1973, Sundstrom 1969).

Temperature is usually not a limiting factor. Fawns may die, however, from unseasonable snow or freezing rain (Sundstrom 1968a).

Snow accumulation determines the time and extent of pronghorn movement. The deeper the snow and more rapid the accumulation, the further and faster herds travel toward lower elevations, sometimes traveling as far as 144 kilometers (90 mi) (Mason 1952).

Soil

The best pronghorn habitats in the Great Basin are found on Aridisols and Mollisols which evolved under a regime of 25-38 centimeters (10-16 in) of precipitation per year.

Water

Pronghorns require water throughout the year. Springs, rivers, streams, lakes, reservoirs, catchments, and troughs provide drinking water much of the year; snow provides water during winter.

Rangelands providing optimum habitat have drinking water available at intervals less than 8 kilometers (5 mi) (Sundstrom 1968b). Some animals may be found further than 8 kilometers (5 mi) from water, but Sundstrom (1968b) observed that 95 percent of over 12,000 pronghorns were within 4.8 to 6.4 kilometers (3 to 4 mi) of water.

Water consumption by pronghorns varies inversely with the quality and succulence of available forage. When succulent forage is available, 1 liter (0.25 gal U.S.) of water per animal per day is sufficient. When succulence exceeded 75 percent, animals did not drink (Beale and Smith 1970). During dry summers, 4.2-5.7 liters (1.1-1.5 gal U.S.) per day may be needed (Beale 1966).

Drought can reduce the vitality and fertility of pronghorn (Hailey and others 1966, Jones 1949). Pronghorns have killed themselves trying to get through fences to reach water (Baker 1967).[1]

Water quality—particularly total dissolved solids, alkalinity, and pH—is important for pronghorns. The maximum total dissolved solids suitable for ungulate wildlife is 4,500 ppm (McKee and Wolf 1963). Sundstrom (1971) found little use of water with total dissolved solids in excess of 5,000 ppm, and limited use of a source containing 4,620 ppm. Water with pH over 9.25 was not used. Criteria for water quality suitable for livestock and wildlife are given in the tabulation below; the data are interim, however, and should be used only until more precise data are available.[2]

Criteria	Maximum allowed
Total dissolved solids	[3]10 000 mg/liter
Free chlorine	200 mg/liter
pH	7.0-9.2
Manganese	10 mg/liter
Alkalinity (as $CaCo_2$)	50 mg/liter
Chlorides	1 500 mg/liter
Chromium	5 mg/liter
Hardness	500 mg/liter

BIOTIC FACTORS

Vegetation

Quality and quantity of vegetation are primary influences on pronghorn density. Sagebrush steppe preferred by pronghorns is characterized by Yoakum (1974):

1. Ground cover. Ground cover averages 50 percent living vegetation.
2. Composition. Vegetation averages 40-60 percent grasses, 10-30 percent forbs, and 5-20 percent shrubs.

[1] Baker, Ted C., Federal Aid Coordinator, Wyoming Game and Fish Commission, Cheyenne. Personal communication; 1967.

[2] U.S. Department of Agriculture, Forest Service, Southwestern Region. Water quality interim guidelines. 1968. Unpublished report on file at USDA Forest Service, Albuquerque, NM.

[3] This figure is probably excessive.

3. Variety. The number of plant species varies from 5 to 10 grasses, 20 to 40 forbs, and 5 to 10 shrubs.
4. Succulence. Succulent plants are preferred forage (Beale and Smith 1970), especially during spring and in some particularly moist summers (fig. 4). Pronghorns move from dry upland ranges to intermittent lake beds and playas to graze succulent vegetation (Good 1977). They also make disproportionate use of recently burned rangelands for foraging, especially in the first growing season after fire. Such areas often provide succulent grass sprouts and an abundance of forbs (Beardahl and Sylvester 1976, Stelfox and Vriend 1977).
5. Range. Open rangelands supporting several plant communities are preferred over monotypic vegetation (Sundstrom and others 1973, Yoakum 1957).
6. Height. Low vegetative structure, averaging 38-61 centimeters (15-24 in) is best. Areas with vegetation taller than 61 centimeters (24 in) are used less; areas with vegetation more than 76 centimeters (30 in) tall are seldom used. Such tall vegetation restricts the pronghorn's ability to see and run—attributes which combine to form the animal's primary defense.

Animal

Pronghorns historically coexisted in various parts of their extensive range with other ungulates such as bison, elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), and bighorn sheep (*Ovis canadensis*) (Einarsen 1948, Nelson 1925, O'Gara 1978, Yoakum 1978b). The bison, especially, grazed dominant grasses, restricting growth of the grass and enhancing production of the forbs and browse favored by pronghorns (Peden 1972).

Coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and golden eagles (*Aquila chrysaetos*) prey on pronghorns, especially fawns (Beale and Smith 1970, 1973; Compton 1958; Hinman 1961; Udy 1953). Bobcat predation on young pronghorns can depress populations on some ranges under certain circumstances (Beale and Smith 1970, 1973). Poor nutrition magnifies the impact of predation (Beale and Smith 1970, Hailey and others 1966). Generally, where habitat is adequate, predation is not a major limiting factor.

Figure 4.—An adult doe eating succulent forbs from a community of grasses. (Photograph by James Yoakum.)

Human disturbance can be particularly harmful on winter ranges and during fawning. Snowmobiles, motorcycles, and low flying aircraft may cause adverse effects.

Habitat Characteristics

Preferred ranges have shrubs with a mean height of 38 centimeters (15 in) (Yoakum 1974). Low sagebrush (*Artemisia arbuscula*) dominates commonly used summer ranges. The best winter ranges are dominated by shadscale saltbush (*Atriplex confertifolia*), black sagebrush (*Artemisia nova*), and winterfat (*Ceratoides lanata*).

Areas dominated by big sagebrush (*Artemisia tridentata*) are less used, probably because of tall growth of the plant. Alteration of big sagebrush communities by fire or by plowing and chaining to control shrubs increases their acceptance to pronghorns (Yoakum 1978a).

Stands of exotic crested wheatgrass (*Agropyron desertorium* and *A. cristatum*) which include succulent forbs such as dryland alfalfa have become accepted habitats when located near occupied ranges and adequately supplied with

water (Heady and Bartolome 1977). When autumn growth of crested wheatgrass and forbs occurs, and the snow cover which follows is light, these rangelands are wintering habitat.

Management Relationships

The pronghorn population in Canada and the United States increased 1,500 percent from 1924 to 1976 (Yoakum 1978b). Control of hunting and large scale transplanting activities reestablished herds on many historic ranges.

Rangeland management (including vegetation alteration, fence construction, water development, and manipulation of livestock use) influences pronghorn habitat. Management planning that considers pronghorn requirements can minimize adverse effects on pronghorn habitat; some habitat improvement may result. If pronghorn's requirements are ignored, however, severe habitat damage can occur (Wagner 1978).

Nearly all rangelands inhabited by pronghorns are also used by domestic livestock—primarily cattle, sheep, and horses. Utilization of forage in 1975 on the Bureau of Land Management's Vale district in southeastern Oregon is shown in the tabulation below (Heady and Bartolome 1977). Pronghorns consumed less than 1 percent of forage, whereas domestic livestock consumed 83 percent.

Domestic species	Percent forage use
Cattle and horses	82.3
Sheep	0.7
Feral horses	5.8
Total	88.8
Wild species	
Pronghorns	0.9
Mule deer	10.1
Bighorn sheep	0.1
Rocky Mountain elk	0.1
Total	11.2

Insufficient forage for current herbivore populations creates competition for that which is available. Studies of food habits of horses, cattle, domestic sheep, and pronghorns on sagebrush grasslands have shown that horses, cattle, and sheep on sagebrush-grasslands have similar food habits (Olsen and Hansen 1977). Pronghorns do not compete with either horses or cattle when forage and water are abundant. Competition between domestic sheep and pronghorns, however, is more pronounced (Buechner 1950, Hoover and others 1959, Severson and May 1967).

The effect of feral horses on pronghorn habitat is largely conjecture. Meeker (1979) studied interactions between pronghorns and feral horses for one summer in northeastern Nevada and observed no competition at watering sites or interspecific acts of aggression, but evidence of a symbiotic relationship, and a dietary overlap of 12.8 percent.

There have been no analyses of the effects of livestock grazing systems on pronghorns for the Great Basin. Most rangelands in southeastern Oregon no longer support yearlong livestock grazing (Heady and Bartolome 1977). Grazing systems are now based on seasonal needs of livestock while satisfying the physiological requirements of the preferred plant species.

Pronghorns thrive best on ranges with subclimax vegetative composition. These structural and vegetal conditions are created by fire and by the foraging of wild and domestic herbivores. The variety of forbs, grasses, and shrubs is often higher when the species composition and structural conditions of a plant community are typical of midsuccession.

The quality of rangeland for pronghorns in southeastern Oregon is described by combinations of habitat components identified in fig. 5. An example of how to use the form for rating pronghorn habitat as summer and winter range is shown in fig. 6. Where optimum or near optimum vegetative conditions exist, it is best to maintain the plant structure and composition[4] (Yoakum 1980).

[4] Kindschy, Robert R. The Vale project and wildlife ecology. 1971. Unpublished report on file at the U.S. Department of the Interior, Bureau of Land Management, District Office, Vale, OR.

WORK SHEET FOR RATING PRONGHORN HABITAT

(sagebrush steppe)

Step 1. Circle the most appropriate response in side A of each column (complete cols. 1-7 for rating summer range, cols. 2-4 and 6-7 for winter range). Fill in at bottom corresponding percent of optimum from side B.

Col. 1* Availability of water		**Col. 2** Vegetative ground cover		**Col. 3** Vegetative ground cover		**Col. 4** Vegetative height		**Col. 5*** Vegetative succulence		**Col. 6** Fences		**Col. 7** Slope	
Distance between water in kilometers (miles)	Percent of optimum	Percent shrubs	Percent of optimum	Percent forbs	Percent of optimum	Height, in centimeters (inches)	Percent of optimum	Forbs green	Percent of optimum	Type	Percent of optimum	Percent grade	Percent of optimum
A	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
1. 3.2 or less (2 or less)	100	1. 5-20	100	1. 0-10	32	1. 25 or less (10 or less)	90	1. All summer	100	1. None	100	1. 0-5	100
2. 3.3-6.4 (2.1-4.0)	85	2. 20-30	53	2. 10-30	100	2. 25-50 (10-20)	100	2. To July 15	75	2. 3-strand barbed wire	90	2. 5-10	75
3. 6.5-9.7 (4.1-6.0)	57	3. 30-40	27	3. 30-50	33	3. 50-76 (21-30)	50	3. To July 1	50	3. 4-strand barbed wire with 41+ cm (16+ in.) clearance	80	3. 10-30	50
4. 9.8-12.9 (6.1-8.0)	30	4. 40-50	15	4. 50-70	17	4. 76-102 (31-40)	10	4. To June 15	25	4. Woven, 81 cm or less (32 in. or less) high	70	4. 30+	25
5. 13.0-16.0 (8.1-10.0)	12	5. 50-70	5	5. 70-90	10	5. 102-127 (41-50)	5	5. To June 1	10	5. Woven, 81+ cm (32+ in.) high	30		
6. 16.1+ (10+)	0	6. 70+	3	6. 90-100	5	6. 127+ (51+)	0						
Percent of optimum scored:	*						*		*				
	Col. 1		Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7

Step 2. Calculate habitat rating. Summer range: (a) Sum of the percents of optimum (step 2, cols. 1-7)÷7 = summer habitat rating.
(b) The column with the lowest percent of optimum shows the habitat component most limiting the quality of pronghorn habitat. The lowest percent = primary habitat limiting factor.

Winter range: (a) Sum of the percents of optimum (step 2, cols. 2-4, 6-7)÷5 = winter habitat rating.
(b) The column with the lowest percent of optimum shows the habitat component most limiting the quality of pronghorn habitat. The lowest percent = primary habitat limiting factor.

* Do not complete when rating winter range.

Figure 5.—Worksheet for rating pronghorn habitat (sagebrush steppe).

WORK SHEET FOR RATING PRONGHORN HABITAT

(sagebrush steppe)

Step 1. Circle the most appropriate response in side A of each column (complete cols. 1-7 for rating summer range, cols. 2-4 and 6-7 for winter range). Fill in at bottom corresponding percent of optimum from side B.

Col. 1* Availability of water		**Col. 2** Vegetative ground cover		**Col. 3** Vegetative ground cover		**Col. 4** Vegetative height		**Col. 5*** Vegetative succulence		**Col. 6** Fences		**Col. 7** Slope	
Distance between water in kilometers (miles)	Percent of optimum	Percent shrubs	Percent of optimum	Percent forbs	Percent of optimum	Height, in centimeters (inches)	Percent of optimum	Forbs green	Percent of optimum	Type	Percent of optimum	Percent grade	Percent of optimum
A	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
1. 3.2 or less (2 or less)	100	1. 5-20	100	1. 0-10	32	1. 25 or less (10 or less)	90	1. All summer	100	1. None	100	1. 0-5	100
2. 3.3-6.4 (2.1-4.0)	85	2. 20-30	53	2. 10-30	100	2. 25-50 (10-20)	100	2. To July 15	75	2. 3-strand barbed wire	90	2. 5-10	75
3. 6.5-9.7 (4.1-6.0)	57	3. 30-40	27	3. 30-50	33	3. 50-76 (21-30)	50	3. To July 1	50	3. 4-strand barbed wire with 41+ cm (16+ in.) clearance	80	3. 10-30	50
4. 9.8-12.9 (6.1-8.0)	30	4. 40-50	15	4. 50-70	17	4. 76-102 (31-40)	10	4. To June 15	25	4. Woven, 81 cm or less (32 in. or less) high	70	4. 30+	25
5. 13.0-16.0 (8.1-10.0)	12	5. 50-70	5	5. 70-90	10	5. 102-127 (41-50)	5	5. To June 1	10	5. Woven, 81+ cm (32+ in.) high	30		
6. 16.1+ (10+)	0	6. 70+	3	6. 90-100	5	6. 127+ (51+)	0						
Percent of optimum scored:	* 30		53		100		* 50		* 50		80		100
	Col. 1		Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7

Step 2. Calculate habitat rating. Summer range: (a) Sum of the percents of optimum (step 2, cols. 1-7)÷7 = summer habitat rating.
(b) The column with the lowest percent of optimum shows the habitat component most limiting the quality of pronghorn habitat. The lowest percent = primary habitat limiting factor.

Winter range: (a) Sum of the percents of optimum (step 2, cols. 2-4, 6-7)÷5 = winter habitat rating.
(b) The column with the lowest percent of optimum shows the habitat component most limiting the quality of pronghorn habitat. The lowest percent = primary habitat limiting factor.

* Do not complete when rating winter range.

Summer range:
Total 1→7 = 463 ÷ 7 = 66% of optimum. Water at 30% = primary limiting factor.

Winter range:
Total 2, 3, 4, 6, 7 = 383 ÷ 5 = 77% of optimum. Veg. height at 50% = primary limiting factor.

Figure 6.—Example of completed worksheet.

Rangeland Manipulation

Manipulating vegetation to increase livestock forage is intensifying in some areas of the Great Basin. An associated activity is modifying the habitat to enhance livestock management and to provide more complete rangeland use; fencing and water developments (fig. 7) are examples.

VEGETATIVE CHANGES

Manipulating vegetation can be either beneficial or detrimental to pronghorns, depending on how it is accomplished (Yoakum 1978b, also see footnote 4). Two basic precautions must be taken: other habitat requirements of pronghorns must be met, and all work should follow the

Figure 7.—Construction of earthern reservoirs provides water for pronghorns in water deficient rangelands of southeastern Oregon. (Photograph by James Yoakum.)

principles of range restoration described by Plummer and others (1968):

1. Changes in plant cover must be justified as biologically desirable.
2. Terrain and soils must be suited to the changes.
3. Precipitation must be adequate to assure establishment and survival of seeded plants (Bleak and others 1965).
4. Competition should not prevent establishment of desired species.
5. Only species and strains of adapted plants should be seeded.
6. Mixtures, rather than single species, should be planted.
7. Sufficiently pure and viable seeds should be planted to increase the probability of success.
8. Seed should be sufficiently covered to enhance sprouting (Basile and Holmgren 1957, Plummer 1943).
9. Planting should be done in the correct season to ensure establishment.
10. The planted area should be adequately protected from livestock, insects, fire, off-road vehicles, etc.

Extensive areas dominated by big sagebrush (where big sagebrush comprises more than 30 percent of the vegetative cover) are marginal pronghorn habitat, especially if the shrubs are taller than 76 centimeters (30 in). Such areas can be treated to decrease the density and height of sagebrush (fig. 8) (Yoakum and others 1980).

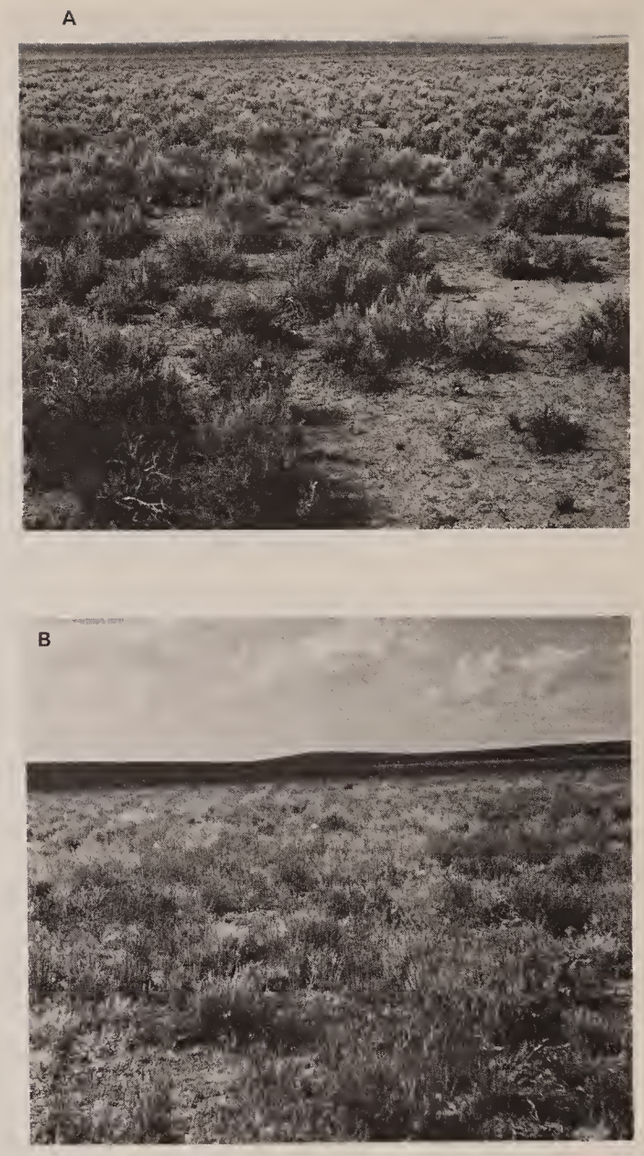

Figure 8.—Results of manipulating vegetation by plowing and seeding: **A**, vegetation before treatment (photographed July 1963); **B**, after seeding (photographed June 1969). The vegetative structure shown in B is more favorable to pronghorns. (Photographs by Robert Kindschy.)

If an area is to be treated, it should probably be no larger than 405 hectares (1,000 acres). The size is based on the assumption that (1) the winter range of pronghorn herds residing in the Great Basin averages 1 215 to 3 025 hectares (3,000 to 5,000 acres) and (2) the treated area should encompass no more than one-third of this winter range. About 5- to 20-percent shrub cover should be retained in the treated area. Because sagebrush and native forbs are important food items (Beale and Smith 1970, Mason 1952, Salwasser 1980, Yoakum 1980), the majority of the natural vegetative communities needed for seasonal use, primarily sagebrush-grasslands, should be retained.

Shrubs are often controlled by mechanical means. Plowing and seeding has been done in many areas of the Great Basin. A brushland plow is often used (fig. 9); this is a disk-type plow developed especially for this purpose. Chaining is another technique widely used. A heavy link ship anchor chain is dragged between two crawler tractors. Chaining does not kill many nonwoody plants or the younger, more flexible shrubs.

Aerial application of herbicide has been a common practice for sagebrush control (Heady and Bartolome 1977). Some applications of 2,4-D have killed nearly all shrubs and perennial forbs. This treatment results in standing dead shrubs that retain their tall structure. Pronghorns usually avoid areas containing such structures for several years (fig. 10).

Historically, fire has been an important influence on the structure of plant communities. Controlled or prescribed fire can control shrubs and is used, on a small scale, as a technique for enhancing habitat. Prescribed burning, properly done, can decrease sagebrush density and enhance opportunities for native grasses and forbs (Beardahl and Sylvester 1976, Lovaas 1976, Page 1975). Fire triggers a series of secondary responses, many of which enhance the habitat for pronghorns. Soil fertility is usually increased. With the canopy removed, soils are warmed by solar heating, promoting earlier vegetative growth in the spring. Plant vigor is increased by removal of senescent shoots and foliage. More forage may become available because some plants become more palatable after burning. Long-term

Figure 9.—A brushland plow converts dominated shrublands to communities with comparatively low structure. (Photograph by Robert Kindschy.)

Figure 10.—Big sagebrush killed by chemical application. The skeletons of the sagebrush persist for years and create an unfavorable habitat for pronghorns. (Photograph by Robert Kindschy.)

increases in vegetative growth may be stimulated by timing the burn to favor species with highest yields, by removing competing plants, and by preparing seedbeds for vegetative production.

If a site treated for shrub control has insufficient plants to ensure reproduction, it can be artificially seeded. Such ventures have usually resulted in monocultures of exotic grasses, however, which have limited value to pronghorns other than reducing the height and number of shrubs. Conversely, seeding mixtures have been beneficial to pronghorns, especially when legumes such as dryland alfalfa were included[5] (fig. 11). A useful rule of thumb is to include a minimum of six palatable species each of grasses, forbs, and shrubs (Plummer and others 1968).

[5] Kindschy, Robert R. Preliminary report on nomad alfalfa seedings. 1974. Unpublished report on file at the U.S. Department of the Interior, Bureau of Land Management, District Office, Vale, OR.

Figure 11.—Using mixtures of forbs and grasses greatly enhances seeded areas as pronghorn habitat. Nomad variety alfalfa and crested wheatgrass were planted in this seeding. (Photograph by Robert Kindschy.)

Pronghorns have used some areas seeded with crested wheatgrass (see footnote 4). Winter use occurs where autumn growth is stimulated by fall rains. Fecal analysis showed that cheatgrass (*Bromus tectorum*), sagebrush, and scarlet globemallow (*Sphaeralcea* sp.) dominated the diet of pronghorns wintering on such areas, crested wheatgrass represented approximately 2 percent.[6]

WATER DEVELOPMENT

Pronghorns drink from many sources of water, including springs, creeks, rivers, lakes and reservoirs, stock water developments, troughs, and devices for catching precipitation or "guzzlers."

Numerous small reservoirs have been constructed in southeastern Oregon to trap and store precipitation for use by livestock and ungulate wildlife (see fig. 7). Many of these have been constructed on public lands through cooperative funding by State wildlife organizations and Federal land management agencies. In Malheur County, Oregon, 1,037 such reservoirs have been built (Heady and Bartolome 1977).

Another water development valuable to pronghorns is the charco pit or dugout (fig. 12). These earthen pits entrap and store precipitation primarily for livestock and wildlife, but they are readily used by pronghorns, especially during hot late summer months when vegetation is desiccated, and the animals' requirement for water increases.

Wildlife use water from natural springs and seeps. These sources of water are often developed for other uses, such as for livestock, fire suppression, and humans. With minor modifications, such as placing troughs low on the ground, these developments can benefit pronghorns (fig. 13).

Guzzlers can provide water on ranges otherwise lacking in potential sources (June and Higby 1965, Sundstrom 1968b, U.S. Department of the Interior, Bureau of Land Management 1964).

[6] Spalinger, Don. Notes on the food habits of pronghorn antelope on the Rome seeding, Oregon, during late winter, 1977, with special reference to crested wheatgrass use. 1979. Unpublished report on file at the U.S. Department of the Interior, Bureau of Land Management, Reno, NV.

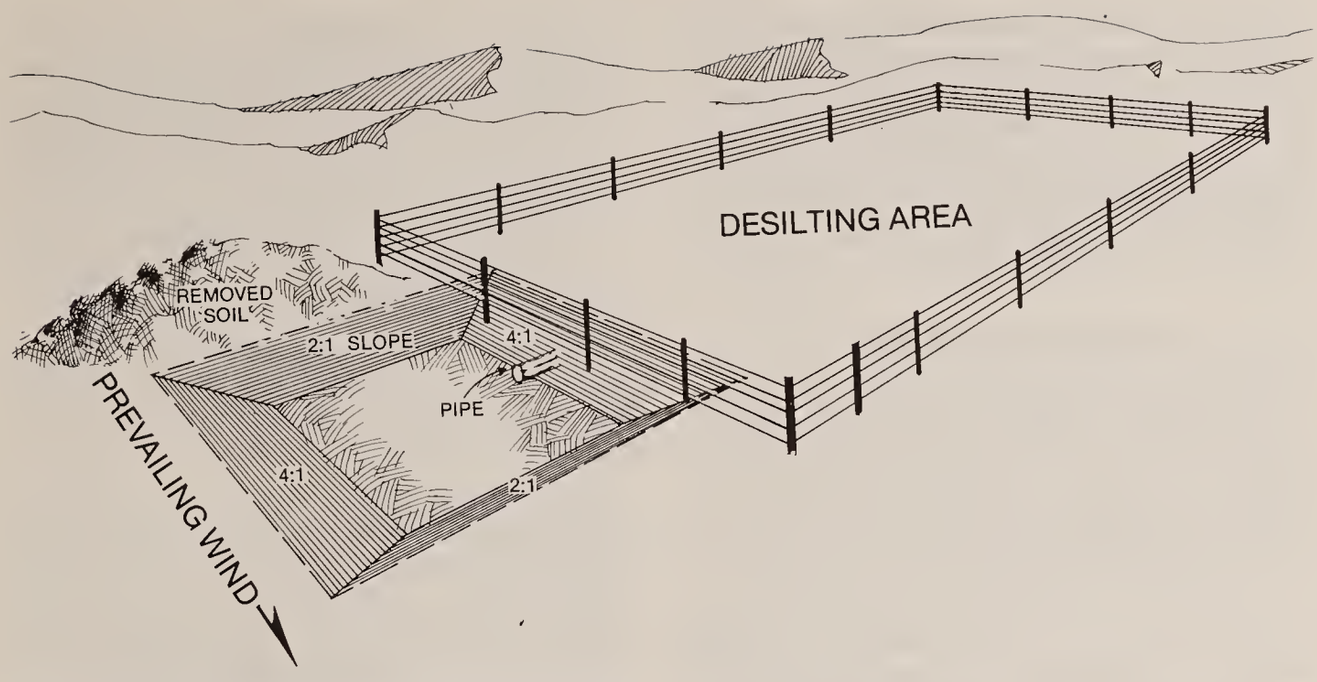

Figure 12.—Charco pit. (Adapted from Yoakum 1980.)

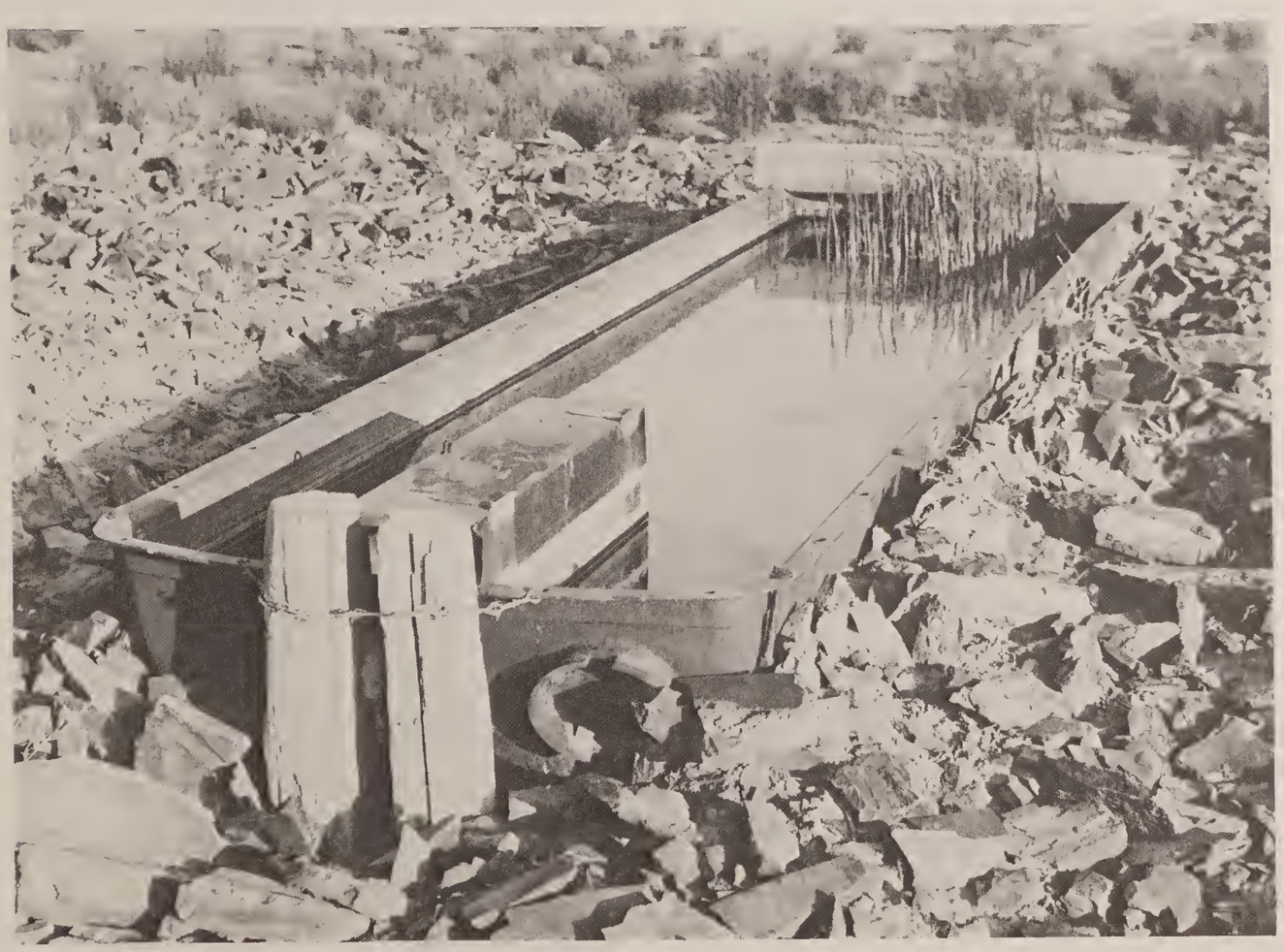

Figure 13.—This trough for livestock and wildlife receives water through a 5-mile pipeline. The trough was installed at ground level to facilitate use and was surrounded by rocks to prevent miring by ungulates. (Photograph by James Yoakum.)

They require little maintenance, are relatively inexpensive, and serve a variety of wildlife. A three-strand barbed wire fence 81 centimeters (32 in) high with a smooth bottom wire at least 41 centimeters (16 in) above the ground can be constructed to exclude cattle and horses. Such construction still allows pronghorns to use the water, but restricts livestock.

LIVESTOCK FENCING

Fences can restrict the movement of pronghorns, causing changes in herd distribution, deaths, and losses in carrying capacity due to isolation of ranges (Bruns 1977, Hailey and others 1966, Martinka 1967, Oakley 1973, Sundstrom 1970).

The following specifications, resulting from intensive studies, are recommended for fence construction in areas used by pronghorns (Mapston 1972; Spillet and others 1967; U.S. Department of the Interior, Bureau of Land Management 1974, 1975; Zobell 1968):

1. The use of woven or net-wire fences should be minimized.
2. Areas encircled by the types of fences that hinder pronghorn movement should be large enough to include their yearlong habitat needs.
3. Pathways and migration routes of pronghorns should have low fences, lay-down panels, pass structures, or adjustable spacing of the wire (Yoakum 1980).
4. Barbed wire fences with no more than three strands can be negotiated by pronghorns. The bottom wire should be smooth (no barbs) and be at least 41 centimeters (16 in) above the ground. Remaining wires shoud be spaced at 25-centimeter (10-inch) intervals. The total height of the fence should not exceed 91 centimeters (36 in), and there should be no stays between posts (fig. 14).

New fences should have white rag flagging tied to the top wire between each post. Pronghorns will, to some extent, adapt to the fence by the time the flagging deteriorates.

Although pronghorns normally pass under or through fences, some learn to jump fences up to 81 centimeters (32 in) high. Woven wire fences are sometimes considered necessary to control domestic sheep. Of the designs tested, the least detrimental to pronghorn passage were (1) a span of net or woven wire 81 centimeters (32 in) high without single strand(s) of wire above, or (2) a span 66 centimeters (26 in) high with one barbed wire 10 centimeters (4 in) above the net wire (Spillet 1965).

Management Tips

Where pronghorns are selected as a featured species for management and their welfare is an objective of management, the limiting factor(s) for each range should be identified and appropriately altered if habitat is to be improved (see figs. 4 and 5). Following are suggestions, including guidelines from the 1978 pronghorn antelope workshop (Autenrieth 1978):

Figure 14.—Specifications for livestock fences constructed of barbed wire on pronghorn ranges (U.S. Department of the Interior, Bureau of Land Management 1975).

HABITAT

1. Where precipitation is less than 15 centimeters (6 in) per year, the vegetation should not be manipulated.

2. The best ranges have at least 50-percent ground cover and the vegetative structure is no taller than 38-61 centimeters (15-24 in).

3. A vegetative composition that averages 40-60 percent grasses, 10-30 percent forbs, and 5-20 percent shrubs is best.

4. High diversity in vegetation is preferable: 5-10 grass species, 20-40 forb species, and 5-10 shrubs.

5. Where plants are seeded, it is important to select species that will ensure succulence into late summer. Dryland alfalfa is an example. Maintenance, improvement, or creation of wet meadows is likewise important.

6. Livestock grazing systems designed to ensure sufficient seasonal forage can also benefit pronghorn. For example, the number of livestock on spring pronghorn ranges can be adjusted to assure growth of vernal forbs, and sheep can be restricted from pronghorn fawning areas for 15 days before and after the peak fawning season (May 15 to June 15). Adequate forage on winter ranges is particularly important; inadequate forage frequently limits the size of pronghorn herds.

7. Pronghorns require 0.9 kilogram (2 lbs) of air-dried, preferred forage per animal per day (Severson and others 1968). This should be consciously provided through management.

WATER

1. Water sources on pronghorn summer ranges are most beneficial when no more than 4.8 kilometers (3 mi) apart and when they are designed and managed for pronghorns, even when livestock are moved to other pastures. In addition, on livestock summer ranges that serve as critical pronghorn winter ranges, some water sources can be restricted from livestock use. The restriction can help prevent overuse of surrounding vegetation by livestock.

2. Availability of water is particularly important on summer ranges from June through October, when each adult pronghorn requires 1.0 liter (1/4 gal U.S.) per day.

3. Water is most palatable to pronghorn when the pH is less than 9.25 and the total dissolved solids are less then 5,000 ppm.

FENCING

1. Pronghorns fare best when fences for controlling livestock movement have no woven wire and are built in such a way to allow pronghorns to pass.

2. Barbed wire fences with smooth bottom wires at least 41-46 centimeters (16-18 in) above the ground, no stays, and a top wire no higher than 81 centimeters (32 in) allow pronghorns to pass.

3. White-topped steel fenceposts will increase the visibility of the fence.

4. White cloth strips tied to the top wire between posts of a new fence will also increase the visibility of the fence and will allow pronghorns to become used to its location.

5. Lay-down panels or "antelope passes" can be constructed at strategic points to allow pronghorns to move between areas. In addition, gates can be left open when livestock are removed from fenced pastures.

HARASSMENT

Human activities disturb pronghorns. Controlling the use of motor vehicles, particularly off-road vehicles, on summer ranges during fawning season (May 15 to June 15) and on winter ranges when herds are concentrated (December 1 to March 15) will minimize disturbance.

GRAZING

Domestic sheep are generally more competitive with pronghorns for preferred forage than are cattle and horses. In addition, the net wire fences commonly used to contain sheep often limit the movement of pronghorns. Pronghorns usually fare better when grazing with horses and cattle than when grazing with sheep.

Summary

The old adage that "good" range management is "good" for wildlife was probably never true and is no longer acceptable (Thomas 1979), certainly not for pronghorns. Improvements in pronghorn habitat, to date, have largely been a byproduct of management activities to improve conditions for livestock. But pressure for increased livestock production is accompanied by a growing public concern for wildlife. Pronghorns can benefit from range management activities only if their welfare is planned in advance and their habitat requirements are no longer left to chance.

Acknowledgments

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Mule Deer

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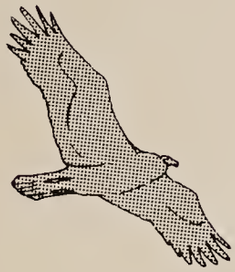
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Mule Deer



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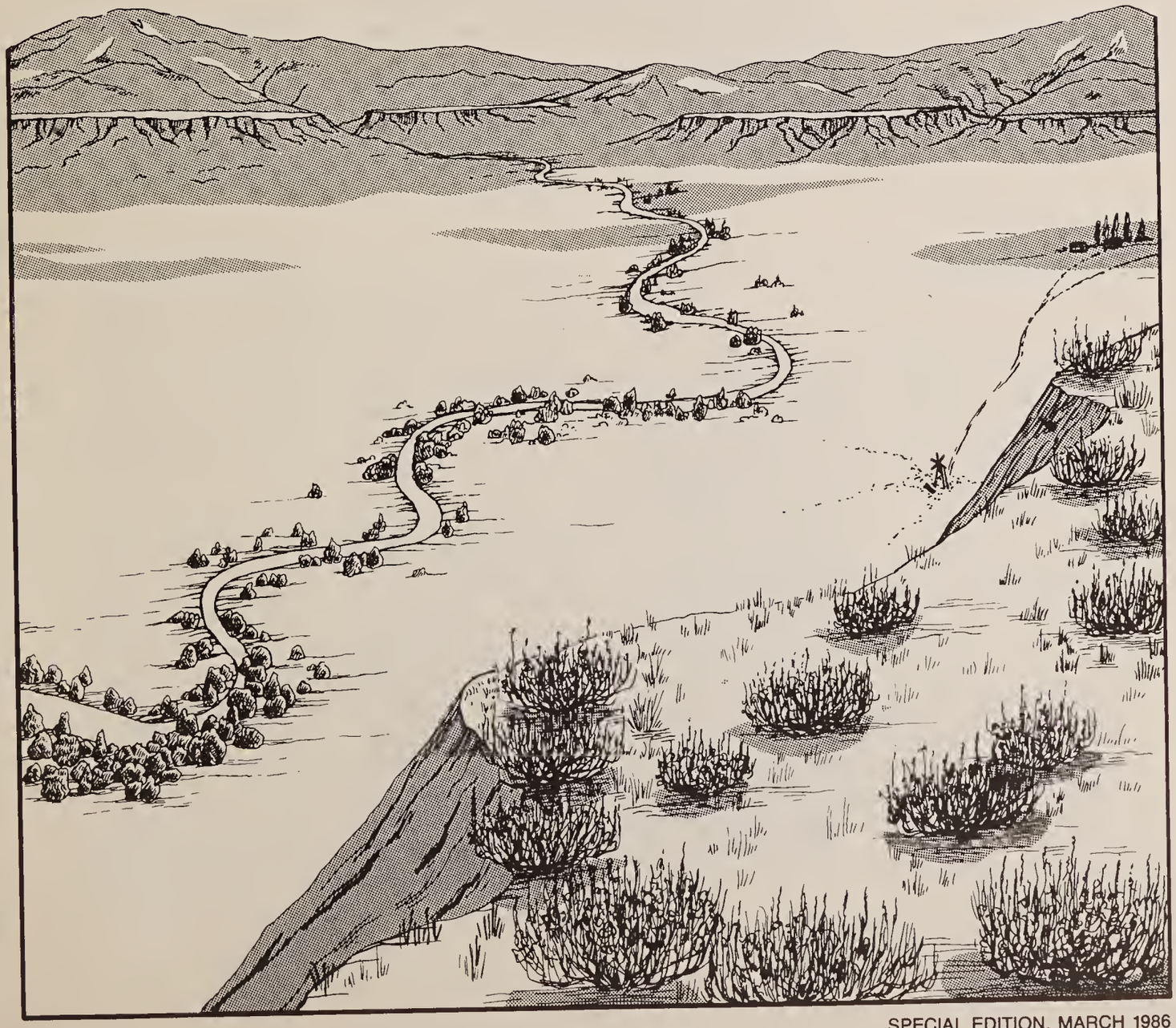

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ABSTRACT

Relationships of mule deer behavior and physiology to management of shrub-steppe plant communities in the Great Basin of southeastern Oregon are presented for application in land-use planning and habitat management. Communities are considered as they are used by mule deer for thermal cover, hiding cover, forage, fawning, and fawn rearing.
KEYWORDS: Deer (mule), wildlife habitat, range management, Oregon (Great Basin).

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon**. The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Wildlife biologists, planners, resource managers, and interested citizens are increasingly involved in planning and allocating uses of public lands. Planning uses of rangeland often requires predicting effects of management on the habitat of mule deer, *Odocoileus hemionus*. Our objective is to describe optimum habitat for mule deer and provide information to help managers predict the consequences of range management alternatives on deer.

Shrub-steppe rangelands are normally managed to increase forage for livestock, but not intentionally managed to either create or maintain vegetative structure compatible with deer needs. Good livestock management—contrary to conventional wisdom—is not always good deer management. Changes in habitat can be made to benefit mule deer or to attain other goals, if such changes are compatible with the site capability (Baker and Frischknecht 1973; Crawford 1975; Hill 1956; Julander 1962; Leckenby 1968, 1970, 1978a; Leopold 1933; Plummer et al. 1968; Reynolds 1964, 1974; Robinette et al. 1952; Thomas et al. 1976, 1979; Tueller 1979; Tueller and Monroe 1975; Verme 1965). Benefits to deer depend on how compatible range management systems are with the physiological and behavioral needs of deer. The key to deer management is habitat management. Habitat is also affected by other range uses, such as agriculture, housing, and recreation. Although meeting projected demands for red meat will require more intensive livestock management (Forest-Range Task Force 1972, USDA Inter-Agency Work Group on Range Production 1974), this need not increase competition between livestock and deer for forage. Livestock grazing can be manipulated to make nutritious food available to wild ungulates at critical times (Anderson and Scherzinger 1975, Bell 1971, deBoer 1970, Leckenby 1968, Willms et al. 1980). Range seedings, of crested wheatgrass[1] for example, can increase forage diversity and maintain cover distributions if extensive monocultures are avoided.

[1] Common and scientific names and their sources are listed in the appendix.

Shrub-steppe ranges generally occur where annual precipitation is below 37.5 centimeters (15 inches) and are characterized by severe climate. Disturbance of vegetation initiates slow successions that do not regain original conditions even when areas are excluded from livestock grazing for up to 30 years (Rice and Westoby 1978, Robertson 1971). Because of the severity of such sites, some induced successional stages have lasted many decades.

Resident deer herds occupy some shrub-steppe ranges the year around. Other migratory herds spend only winters there, causing high animal concentrations on a small portion of the annual range. On such ranges the effects on deer of habitat manipulations are magnified.

Our objectives are to: (1) define optimally productive deer habitat on managed shrub-steppe rangelands; (2) tie deer habitat to plant community and structure; (3) apply these concepts to deer habitat management units; (4) compare consequences of habitat management to deer; and (5) present information that can be used in preparing environmental analyses, habitat management plans, allotment management plans, environmental impact statements, and long-range management plans.

The use of livestock grazing to improve mule deer habitat requires an understanding by resource specialists, managers, and administrators of the habitat requirements of deer and the effects of livestock grazing on deer habitat. The key to this understanding, and to communication about deer, is the common knowledge these specialists have about plant communities.

Understanding of plant communities, their structure, and arrangement in time and space can simplify discussions of the relationships of deer to their habitat. This is also basic to understanding interactions of ecological factors, evaluating their relative influences, and predicting the results of manipulation.

The relationships between deer and their habitat and the consequences of management actions described here apply primarily to the Great Basin of southeastern Oregon—specifically the Lake and Owyhee Desert sections (Holmgren 1972:78-87). The information may

apply generally to similar areas because: (1) much, generally consistent, data is available on mule deer–habitat relationships; (2) shrub-steppe communities are similar; (3) enhancement of livestock grazing dominates land management activities on most ranges; and (4) the basis for management of mule deer habitat is interpreting deer requirements in terms of plant community composition and structure. Extension of our rationale to other geographic areas must be done with caution and by incorporating applicable principles to new data and new knowledge about relationships of deer to habitat for those places.

This chapter is not a techniques manual, a compendium of treatment prescriptions, nor an evaluation of research publications. It is an examination of habitat relationships. We define cover and forage components of optimum deer habitat and describe how changes in plant community structure and composition affect habitat quality.

While we emphasize optimum habitats that allow deer herds to approach maximum productivity, we recognize that deer exist where habitats are less than optimum. We believe that deer habitats on shrub-steppe ranges can be improved by using livestock grazing as a management tool.

The literature and cumulative knowledge concerning deer is extensive and provides several ways to evaluate deer habitat. To narrow these possibilities and to achieve our objectives, we have made the following assumptions:

1. Manipulation of vegetation to benefit livestock is the primary practice that affects deer habitat and will increase as demands for red meat increase.
2. Resource allocations and management influence the welfare and productivity of deer.
3. Cover, forage, water, and space are required by deer.
4. Cover and forage areas are separable habitat components.
5. The diversity, size, arrangement, juxtaposition, and edges of cover and forage areas can be manipulated to achieve predictable changes in deer use and productivity.
6. While deer use the best cover and forage available, the closer to optimum the size, arrangement, and diversity of habitats the higher productivity will be.
7. Herd size is limited by the productivity of plant communities.
8. In situations where forage or cover are limiting deer productivity, and there is competition with livestock, we will consider deer needs first and pinpoint how deer habitat can be enhanced by appropriate livestock grazing systems.
9. Since behavior and tradition largely control deer distribution and movement (Gruell and Papez 1963; Leckenby 1977, 1978a; Mackie 1970; Severinghaus and Cheatum 1956; Zalunardo 1965) and prevent subpopulations of deer from leaving home ranges for adjacent forage and cover, the appropriate management unit is a deer subpopulation range.
10. Range treatments produce both immediate, obvious impacts on habitat and long-term, subtle impacts.
11. The plant community is a more obvious and sensitive indicator of present and past environments than combined measures of temperature, insolation, soil, etc. (Daubenmire 1968; DeVos and Mosby 1969; Duffey and Watt 1971; Leckenby 1968, 1970, 1977; Mueller-Dombois and Ellenberg 1974; Roberts 1975).

MANAGEMENT UNITS

Sizes of habitat management units vary with management goals and whether they are based on biological or political grounds, or both. Existing political units, such as States, National Forests, Ranger Districts, and counties can be convenient for administration but are too large for management of deer habitat. Herd ranges, usually defined by a combination of natural and administrative boundaries (Dasmann 1971, Hunter and Yeager 1956), or seasonal ranges, defined by drainages, ridgelines, or roads, permit increased administrative sensitivity to deer needs, but both are too large to allow managers to identify and monitor specific habitat conditions. The largest unit that is administratively practical and, at the same time, sufficiently sensitive to deer-habitat relationships is the range of a subpopulation. A subpopulation is an aggregation of two types of social groups that occupy a specific area: females with fawns and adult males. A subpopulation range encompasses the separate home ranges of several groups of does with fawns and groups of bucks.

Since our objective is to define optimum habitat for deer, we have adopted the subpopulation range as the most appropriate management unit and use it in this publication. It is large enough to be administered effectively yet small enough to allow monitoring of deer responses to habitat. Subpopulation ranges are large enough to accommodate livestock grazing allotments, allow manipulation of cover and forage areas over time, and suit pasture rotation designs; yet they are also small enough that two or more can be combined as a larger element of a coordinated management plan.

Subpopulation ranges are usually 10 to 20 times larger than seasonal home ranges of individual deer, which range from 50 to 1 240 hectares (120 to 3,060 acres) and average 260 hectares (640 acres) in widely different habitats (Dasmann 1971, Leckenby 1978b, Leopold et al. 1951, Robinette 1966, Rodgers et al. 1978, Swank 1958, Taber and Dasmann 1958, Zeigler 1978). On steep slopes, ranges of subpopulations appear as corridors. For example, a "subpopulation of the Middle Park deer herd" wintered on Cedar Ridge in an area 6.4 by 1.6-3.2 kilometers (4 by 1-2 mi) (Gilbert et al. 1970:17, 20). A California deer herd consisted of two subpopulations; the average area occupied was 347 km^2 (134 mi^2) in summer and 47 km^2 (18 mi^2) in winter (Leopold et al. 1951:16-19, 49). A subpopulation occupied a corridor about 5 by 10 kilometers (3 by 6 mi) on a shrub-steppe winter range (Leckenby 1978b).

In southeastern Oregon, habitat management units between 2 500 and 4 700 hectares (6,400 to 11,520 acres) approximate subpopulation ranges. These units appear either as corridors on sloping range, about 5 by 10 kilometers (3 by 6 mi), or as blocks on more level range, about 8 to 9 kilometers (5 to 6 mi) on a side. These sizes represent a compromise between maximum sensitivity to deer biology and minimum administrative cost. The number of deer in a subpopulation varies widely with quality of habitat and can range from as low as 20 deer up to 2,000.

PLANT COMMUNITIES AND STRUCTURAL CONDITIONS

Plant communities may be grouped in various ways for different management purposes. We identify groups by dominant plant species (Dealy et al. 1981). We have arranged the multitude of plant communities and seral stages in shrub-steppe succession into five structural conditions:[2] grass-forb, low shrub, tall shrub, tree, and tree-shrub.

Use of Plant Communities by Deer

Deer usually require several plant communities. Daily and seasonally, they use a variety of land and vegetation features for cover and forage. Some communities are used only part of each season, but most communities contribute to the well-being of deer sometime during the year. When deer can meet their needs within a relatively small area, deer productivity will be enhanced because maintenance energy costs will be less (Moen 1968b).

Migratory deer use plant communities on three seasonal ranges (Zalunardo 1965). They migrate from lower elevation winter ranges through spring-fall ranges to higher summer ranges (fig. 1). Fawning usually occurs in upper spring-fall and summer ranges. Most deer gradually disperse over the summer range as snow recedes to higher elevations.

Fall migration is largely influenced by weather. Severe storms often precede migration to winter range. In moderate winters, deer may not move to winter range at all, or they may arrive only after spring growth of forage.

[2] Maser, C., and J.W. Thomas. The relationship of terrestrial vertebrates to the plant communities and structural conditions. Unpublished data on file at Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

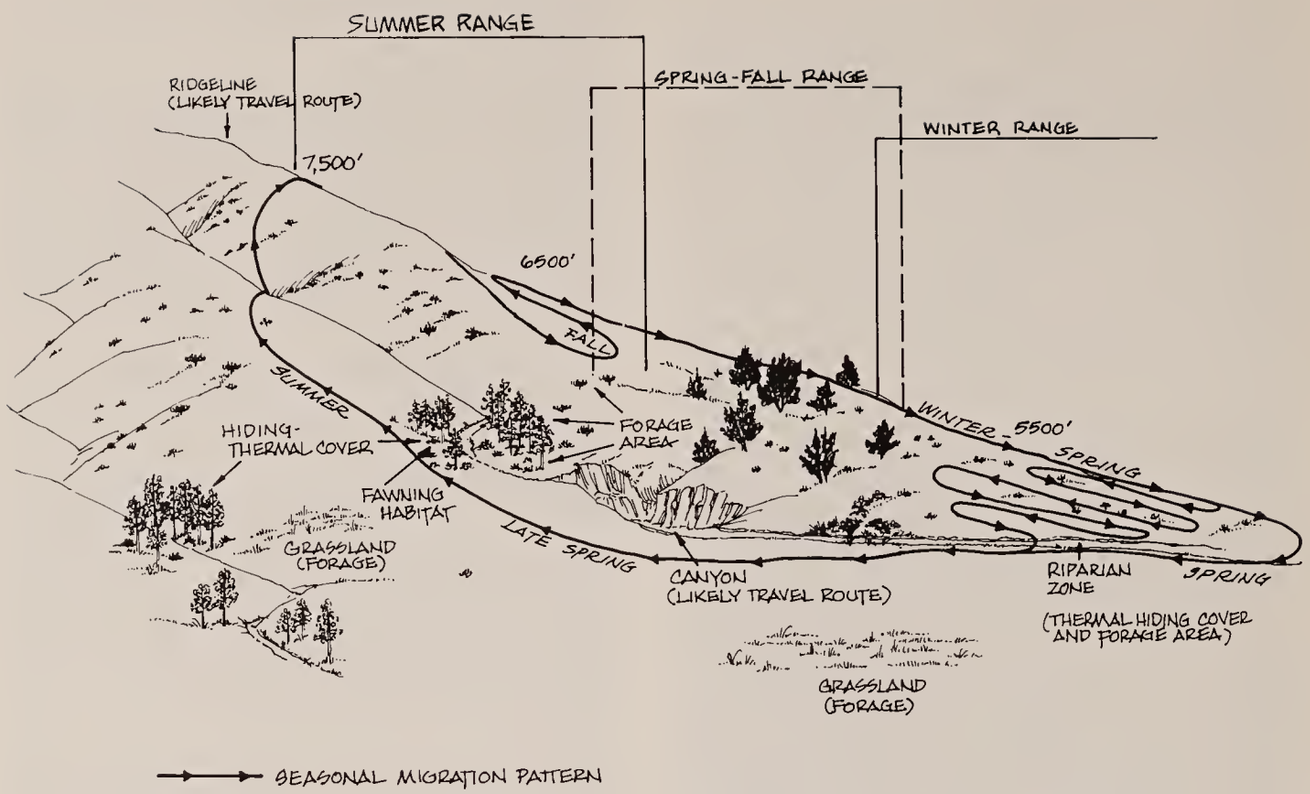


Figure 1. — Use of seasonal ranges depends on how well deer requirements are met by sizes and distribution of habitats relative to ridgelines, canyons, slopes, and flats.

Management Based on Plant Communities and Structure

The number of deer a management unit can sustain is determined partly by the structure, composition, and arrangement of the vegetation, habitat diversity, amount of edge, availability of water, soil productivity, and weather severity. Through manipulation of vegetation structure and composition, habitat diversity, amount of edge, and availability of water land managers can influence the ability of the land to produce deer.

Plant communities, structural conditions, and land features provide the information managers need to predict responses of both animals and vegetation to management and provide a basis for land-use planning (Crawford 1975, Daubenmire 1968, DeVos and Mosby 1969, Mueller-Dombois and Ellenberg 1974). This information includes:

1. Current composition and structure of the vegetation;
2. Soil depth, stability, and suitability for fertilization;
3. Elevation, steepness, position, aspect, shape, and length of slopes;
4. Present type of use by deer and livestock;
5. Past uses for roads, fences, water sources, and grazing;
6. Probable results of treatment and potential effects on productivity.

Deer production is usually greatest in the shrub and tree-shrub structural conditions (Hill 1956, Leopold 1950, Moen 1973). Structural condition can be retarded or advanced by grazing, fire, chemicals, or machinery (Koehler 1975, Plummer et al. 1968, Roberts 1975, Valletine 1971, Willms et al. 1980, Yoakum and Dasmann 1969). The challenge is to plan diversity of habitat and interspersion of cover with forage that will enhance or maintain deer habitat within each subpopulation management unit in areas managed primarily for livestock grazing.

Habitat Requirements of Mule Deer

Optimum habitat for deer is defined as the amount and arrangement of cover and forage areas which result in the greatest use of the most area. Optimum habitat is described here by sizes of stands and their arrangements in time and space to meet needs of deer for thermal and hiding cover, forage areas, and fawning and fawn-rearing habitat.

Range use by deer is not uniform. Habitat conditions often vary between intensively and lesser used areas (Bertram and Rempel 1977, Leckenby 1978b, Owen 1980, Webb 1948). Just how variations in use are related to conditions is not always clear.

COVER

Deer require protection from weather and predation. Because of the usual structure of shrub-steppe communities, where thermal cover is provided, hiding cover is usually also provided (fig. 2). On most range sites, cover is provided primarily by tall shrub species, which in some seasons also provide much of the deer forage. On some management units, cover needs may be satisfied by one plant community, juniper/sagebrush, for example.

Thermal Cover

We define optimum thermal cover for deer within the Great Basin of southeastern Oregon as stands of evergreen or deciduous trees or shrubs, at least 1.5 meters (5 ft) tall, with crown closure greater than 75 percent. Deer will use the best available thermal cover, although it may not be optimum (fig. 3). Structure of vegetation is more important than composition, and levels of crown closure greater than 75 percent appear equally preferred. Thermal cover should be at least 0.8-2 hectares (2-5 acres), since the area of thermal protection increases with stand widths greater than 90 meters (300 ft).

The quality of thermal cover for deer is affected by the following factors and relationships:

1. Net radiation flows are modified by crown closure.
2. Snow depth decreases as crown closure increases.
3. Vegetation taller than deer furnishes diminishing benefits.
4. Sixty-percent crown closure meets minimal year-round needs.

Figure 2. — Shrub-steppe plant communities that provide thermal cover usually provide hiding cover also.

5. Production is greater where there is protection from effective temperatures outside the thermal neutral zone.

These relationships have been observed by Dasmann (1971), Leckenby (1977), Loveless (1964), and Moen (1968b, 1973). The zone of thermal neutrality (Brody 1945, Holter et al. 1975) is that range of temperatures over which an animal's metabolic rate, as measured by heat production, is minimal.

Effective temperature is the result of the combined effects of several factors including air temperature, wind speed, and radiation (Moen 1968b, Porter and Gates 1969). Wind chill (Siple and Passel 1945) is an example of effective temperature derived from air temperatures and wind speeds only.

Deer use evergreen trees and shrubs for thermal cover on winter range and deciduous trees and shrubs as well on summer and spring-fall range (Leckenby 1977, 1978a; Loveless 1964, 1967; Mackie 1970). Topographic features such as rocky bluffs enhance the thermal cover offered by vegetation in some locations and may provide the only thermal cover (Grace and Easterbee 1979, Staines 1976).

Thermal cover allows deer to conserve energy by protecting them from stresses induced by weather. Energy in excess of that required to maintain basal metabolism, regulate temperature, and provide for tissue replacement and necessary activity is then available for productive processes.

Much of the energy in the food of ruminants is used to satisfy basal and maintenance requirements or is lost in waste products. Basal requirements are those necessary to sustain life. These include maintaining minimum body temperature and heart rate. Maintenance requirements are in addition to basal requirements and include travel to and from food and water and replacement of hair coats. If

Figure 3. — Deer will use the best available thermal cover, but cover with some thermal qualities is better than none.

basal requirements are not met the animal will die; if maintenance needs are not met the animal will lose body weight. When basal and maintenance needs are met, energy surpluses are used for production, which includes growth, storage of reserves, reproduction, and care of young (Blaxter 1962; Brody 1945, 1956; Findlay 1954; Grace and Easterbee 1979; Holter et al. 1975; Mitchell 1962; Moen 1968b, 1968c, 1973; Nordan et al. 1970; Ozoga and Gysel 1972; Silver et al. 1969 and 1971).

Temperature regulation in response to thermal stress increases the energy cost of maintenance (fig. 4) and thus takes energy that otherwise could be used in productive processes. Maintenance requirements increase when radiation flows, surface temperatures, air temperatures, wind speeds, and snow depths increase flows of energy **from hot** environments **to** ruminants as well as **from** ruminants **to cold** environments (Chappel and Hudson 1978; Holter et al. 1975; Malechek and Smith 1976; Moen 1968a, 1976; Porter and Gates 1969). In attempts to reduce maintenance costs, deer may remain quiet under thermal cover or may move to cover from open areas that offer only low-energy forage but greater thermal stress (Leckenby 1977, Loveless 1964, Ozoga and Gysel 1972). If their diet meets or exceeds maintenance requirements, however, deer and cattle may bed or stand in exposed forage areas during periods of thermal stress (Malechek and Smith 1976; Moen 1968a, 1968c).

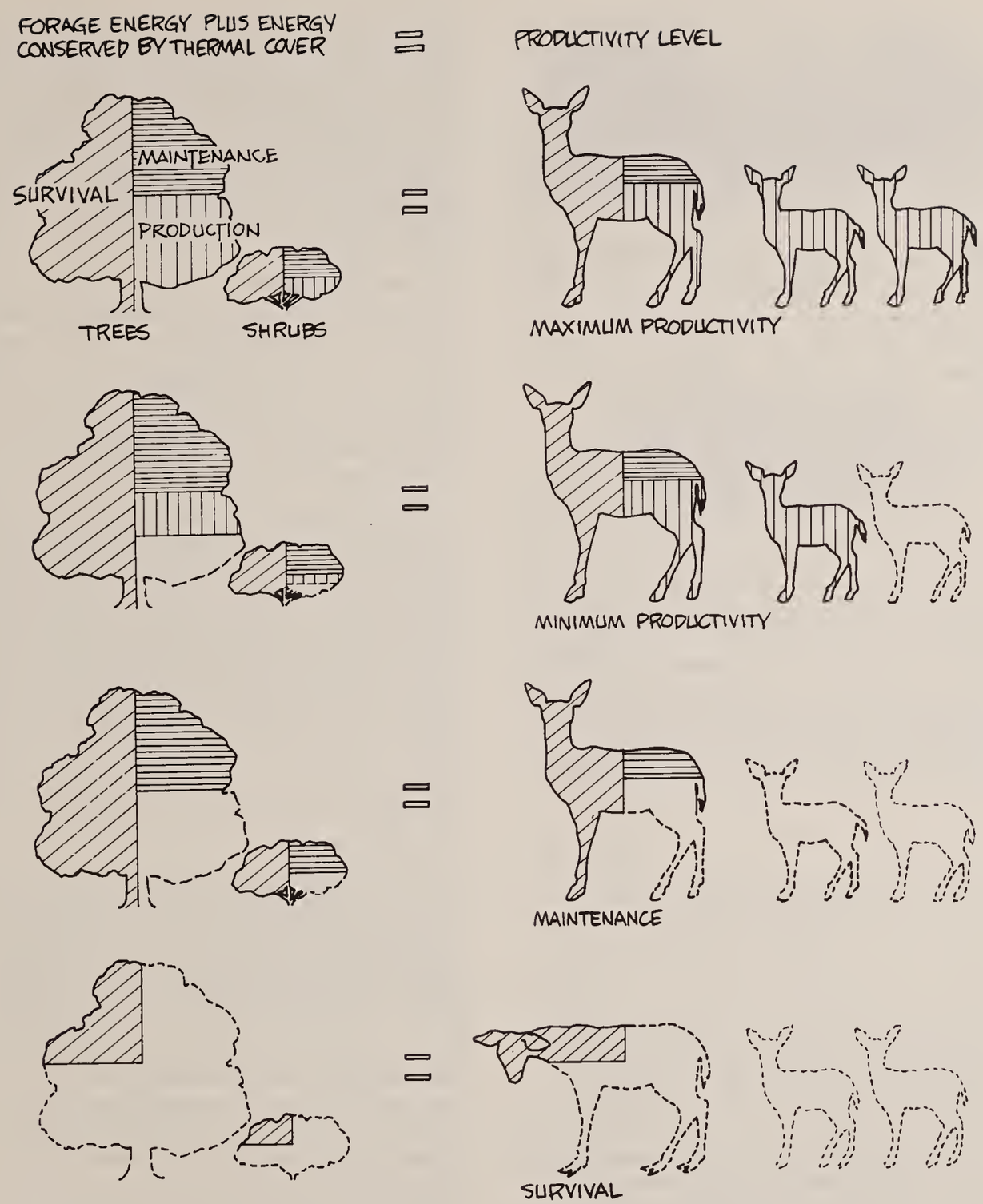


Figure 4. — Productivity of deer varies with the supply of energy available from forage and the thermal cover to conserve it. When quality and quantity of forage and cover is minimal, only survival needs are met. With increasing supplies of both, animals can maintain body weights. As supplies increase further, growth can occur, reserves of fat can be stored, and does can produce fawns and milk.

The thermal neutral zone covers a range of temperatures over which heat production increases only slightly. With temperatures outside that zone, metabolic rate increases rapidly (Blaxter 1962, Brody 1945, Chappel and Hudson 1978, Holter et al. 1975, Moen 1968b). For domestic animals, the shelter and food usually provided the year around broadens the thermal neutral zone, increasing the upper and reducing the lower critical temperatures (Blaxter 1962:116-146). Brody (1945:305-306) suggested that productive efficiency of domestic animals was little affected by temperatures ranging from near zero (18°C) to about 80°F (27°C). The shelter and food available to wild ruminants, however, over much of the year reduces the thermal neutral zone to a narrower range of temperatures.

The thermal neutral zone of white-tailed deer in captivity has been examined in different seasons. A "comfort zone" between 5°C and 20°C (41°F and 68°F) has been suggested for winter, since the estimated minimum level of energy expenditure occurred at about 12°C (54°F), but a thermal neutral zone could not be demonstrated for spring, summer, or fall (Holter et al. 1975). In another study, deer in winter coat increased heat production by only 25 percent at temperatures between 0°C and 20°C (32°F and 68°F), but when the temperature was dropped to -15°C (+5°F) a 75-percent increase was seen (Silver et al. 1971).

The cooling effect of wind may either increase or decrease thermal stress. Winds coupled with temperatures below the thermal neutral zone intensify stress due to cold because the effective temperature is reduced by convective cooling (Grace and Easterbee 1979, Porter and Gates 1969, Siple and Passel 1945, Staines 1976, Stevens and Moen 1970). At temperatures above the thermal neutral zone, winds lower effective temperatures and reduce stress from heat.

Effects of radiation, humidity, and snow on flows of energy to and from wild animals are also of great biological importance (Gilbert et al. 1970; Grace and Easterbee 1979; Moen 1968b, 1973, 1974; Moen and Jacobson 1974; Porter and Gates 1969).

Vegetation structure helps create microclimates. Height, canopy closure and depth, and stem density modify temperature, wind speed, precipitation, and radiation within stands. Reifsnyder and Lull (1965:70) wrote "...the forest can reduce monthly maximum air temperature in the summer by about 10°F below that in the open, reduce annual rainfall (through interception) by 15 to 30 percent, and reduce wind velocities by about 20 to 60 percent." Canopy closure in thermal cover reduced snow depths from 10 to 50 percent of that in shrublands (Leckenby and Adams 1978).

Structural effects have been quantified and can be related to the biology of deer (Bergen 1971, 1972, 1974; Cochran 1969; Gary 1974; Geiger 1966; Gifford 1973; Nudds 1977; Ozoga 1968; Ozoga and Gysel 1972; Reifsnyder and Lull 1965; Stevens and Moen 1970; Verme 1965). Shrub communities also influence microclimate, but less than forests.

Thermal protection is as important in summer as in winter. Lack of protection in summer not only reduces immediate productivity but also lowers reserves necessary for survival during the coming winter. Lack of protection in winter not only threatens immediate survival but also reduces productivity during the following summer. The importance of thermal protection in summer could not be fully appreciated until annual cycles in body weight of deer were documented (Robinette et al. 1973, Short et al. 1969, Silver et al. 1969, Wood et al. 1962, Wood and Cowan 1968).

Optimum microclimates for deer require more than 50-percent canopy closure (Verme 1965). Incoming and outgoing radiation will substantially increase or decrease surface temperatures at less than 50-percent closure. Canopy closures greater than 50 percent create more constant and less stressing microclimates by minimizing fluctuations of incoming and outgoing radiation. In the Great Basin, where temperatures are often outside the thermal neutral zone for deer, 60-percent canopy closure is the minimum criterion for thermal cover.

The severity of temperature, wind, precipitation, and radiation in forage areas surrounded by cover stands increases with the ratio of forage-area diameter to height of the adjacent cover stand; density of nearby cover has an important but smaller effect (Cochran 1969, Geiger 1966, Gifford 1973, Reifsnyder and Lull 1965, Verme 1965).

Riparian habitats in rangeland areas are extremely valuable for thermal cover and are used intensively by wildlife, livestock, and people. This habitat usually combines in a small area the vegetative and topographic components that together fulfill most deer requirements. Riparian zones also receive intensive livestock use because of the availability of thermal cover, green forage, and water. People prefer riparian habitats for fishing and water-oriented recreation. Thus, when thermal stress occurs, deer compete with other big game, livestock, and people for riparian zones.

Hiding Cover

Managers assume that deer require hiding cover (also called escape or security cover by some authors) to make maximum use of a range (Bertram and Rempel 1977, Dasmann 1971, Nudds 1977, Owen 1980, Reynolds 1972). We define optimum hiding cover on shrub-steppe rangeland as vegetation at least 60 centimeters (24 inches) tall and capable of hiding 90 percent of a bedded deer from view at 45 meters (150 ft) or less (the sight distance after Thomas et al. (1979:109), figs. 5 and 6). Owen (1980) detected significant associations between visual density of vegetation and activities of free-ranging mule deer.

Sight distances differ between stands because of differences in plant characteristics and seasonal changes caused by plant phenology. Tall shrubs provide adequate hiding cover for some activities. Low shrubs often hide bedded fawns at less than 1.5 meters (5 ft) during summer. But both shrubs and trees are often required to hide deer against a snowy background at less than 800 meters (½ mi).

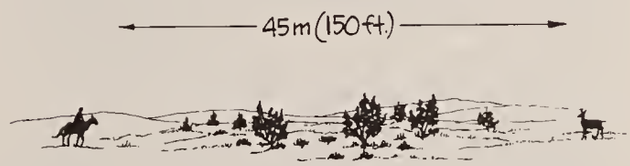
Areas of hiding cover should be between four and eight sight distances wide (190 to 380 meters or 600 to 1,200 ft). Patches of hiding cover as small as 2 to 10 hectares (6 to 26 acres) are probably sufficient for social groups of deer. Optimum distribution of hiding cover within a management unit consists of continuous, interconnecting zones and scattered patches (fig. 7). Canyons and ravines supplement and enhance vegetative hiding cover. Although topography may produce a visual barrier between an animal and a predator or a road and distance may improve security, deer may still feel vulnerable without vegetative cover. On short sagebrush and grass rangelands deer substitute distance and topography for vegetative cover. "Safe" distance varies with time of year, health and activity of the animal, and experience and conditioning of the animal to varied forms of disturbance and harassment. Although distance and topography, by definition, do not provide optimum hiding cover in large open areas, they may provide a partial substitute.

DEER 90 PERCENT HIDDEN AT 45m. (150 ft.) IN MOUNTAIN BIG SAGEBRUSH

DEER 90 PERCENT VISIBLE AT 45m (150 ft.) IN LOW SAGEBRUSH

Figure 5. — Vegetation that hides 90 percent of a bedded deer from view at 45 meters (150 ft) qualifies as hiding cover, provided the stand is at least 190 meters (600 ft) wide. Low shrub communities offer little hiding cover.

Figure 6. — The distance at which a deer is 90 percent hidden from view is defined as the "sight distance" (after Thomas et al. 1979). Hiding cover requires that sight distance be no more than 45 meters (150 ft).



ONE SIGHT DISTANCE

Figure 7. — Ideal mule deer range consists of a mosaic of plant communities arranged to provide thermal cover, hiding cover, and forage areas of optimum structure and size.

FORAGE

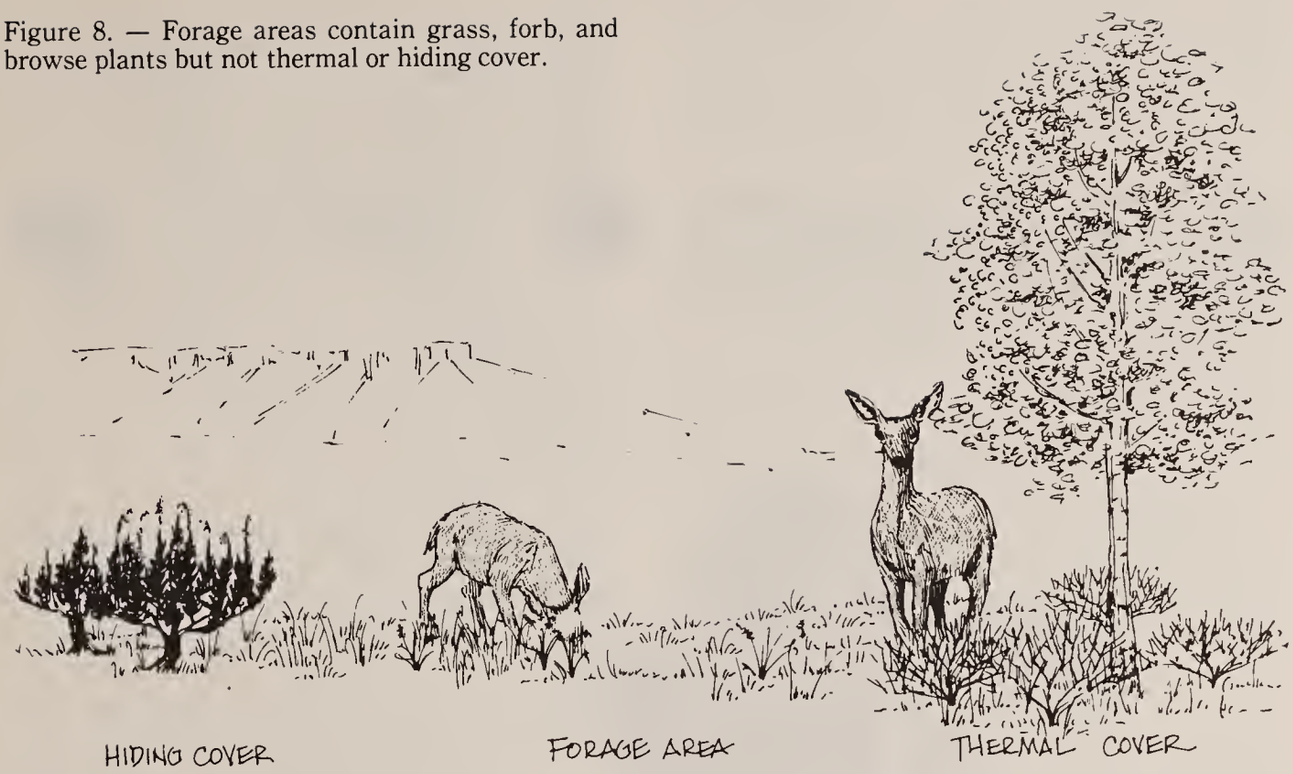
Forage areas are vegetation stands used by deer for grazing or browsing which do not fit the definitions of thermal or hiding cover (fig. 8). This definition assumes that optimum forage areas do not constitute optimum cover areas, although plant species that provide forage at one season often are used primarily for cover at other seasons. For example, big sagebrush and bitterbrush forage may satisfy survival or maintenance needs in fall and winter but are used primarily for cover in spring, when forb and grass species are available to meet maintenance and production requirements (Holl et al. 1979; Leach 1956; Leckenby 1978a, 1978c). Forage and cover types are seldom mutually exclusive on shrub-steppe rangelands, but such habitat division is useful for planning and management.

Livestock and deer often eat the same forage species but the overlap varies with range, season, and class of livestock. It is greatest if livestock and deer occupy the same range when young, green grass and forbs are prominent in the diet of both (Dusek 1975, Hansen and Clark 1977, Hansen and Reid 1975, Longhurst et al. 1979, Smith and Julander 1953). Such dietary overlap works to the advantage of management because livestock graze the cured grasses of species that deer also eat. Thus cattle grazing in summer exposes green forage for deer in fall, and winter grazing by cattle improves forage for deer in spring.

Grazing livestock on mule deer range at appropriate times minimizes direct competition for available forage and assures continued health of range plants. Fall grazing of livestock on deer summer range can be beneficial, provided deer have migrated from the area. Fall grazing by livestock on deer winter ranges can also be beneficial, provided it occurs before greenup and the arrival of deer. Maximum benefits will be realized if livestock remove little of the dormant browse. Spring turnout of livestock on deer winter range should occur following spring greenup and after most of the deer have migrated. It is critical that livestock be removed from deer winter range when soil moisture is still adequate to permit grasses to grow new leaves to replenish nutrient reserves in their roots. If livestock removal is delayed beyond this point, the vigor of forage plants will decline. Continued abuse of plants by such extended grazing will eventually reduce plant productivity, and declines in the productivity of both deer and livestock will soon follow.

Where annual grasses, such as some cheatgrass stands, persist in spite of continued attempts to convert them to native bunchgrass, it might be wiser and more economical to manage those sites for annual grasses instead of seeding them with exotic perennials. Permitting cheatgrass islands in expanses of sagebrush or crested wheatgrass would maintain greater forage diversity than reseeding entire blocks. Fall burning of cheatgrass stands can make nutritious growth available, but the hazards of erosion should be

Figure 8. — Forage areas contain grass, forb, and browse plants but not thermal or hiding cover.

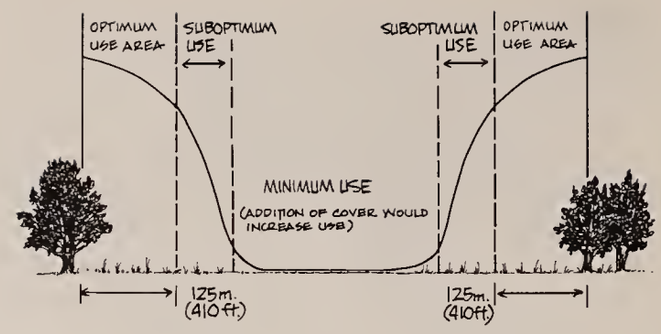


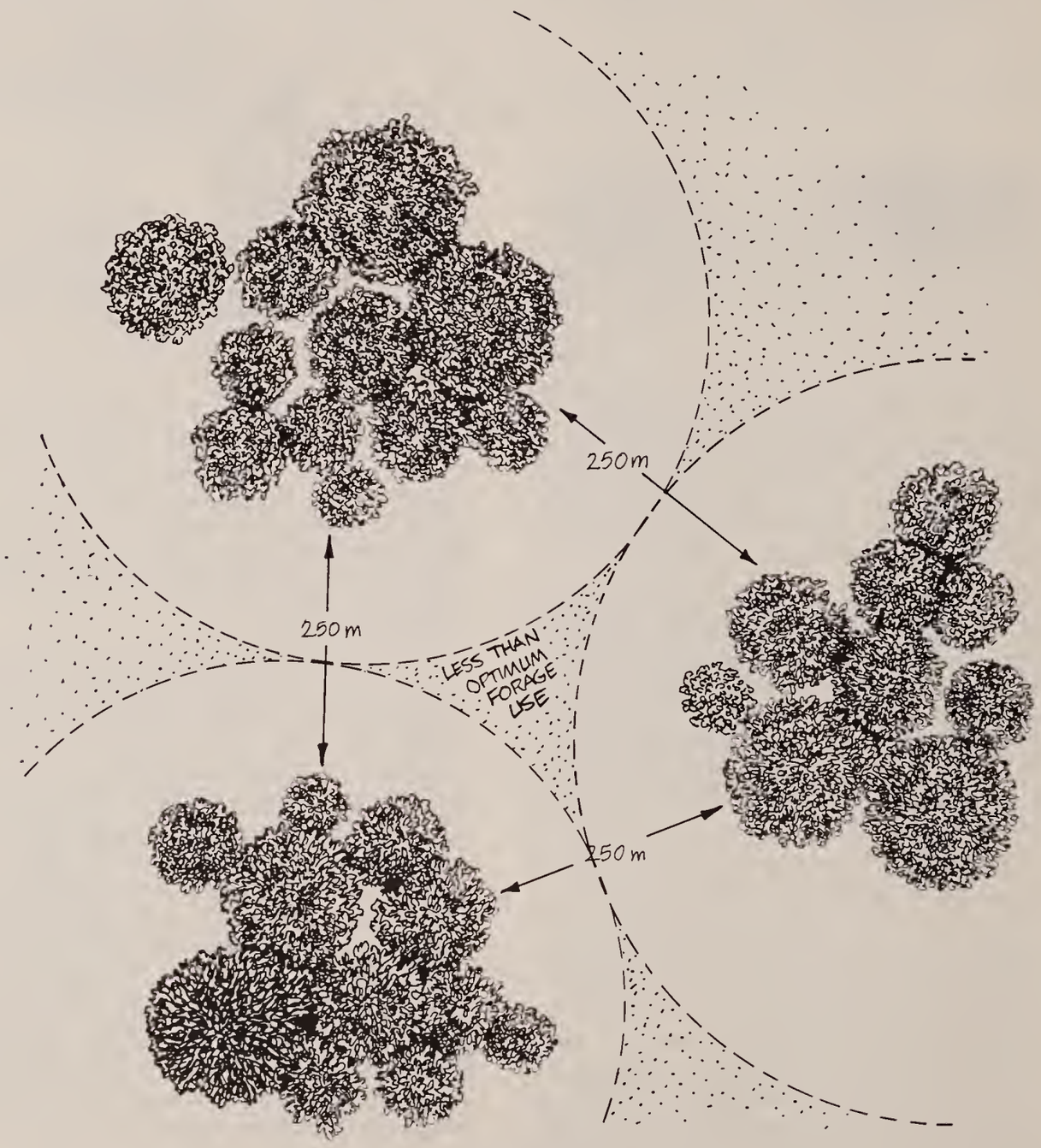
considered. Young cheatgrass is nutritionally rich and it develops earlier in both fall and spring than many native perennials. It is very tolerant to intensive grazing. Because they mature rapidly, however, annual grasses also decline more quickly in forage value than perennial grasses.

The use deer make of forage areas depends on the size and interspersion of cover areas as well as size and arrangement of the forage areas. Deer do not fully utilize forage areas that are too far from cover (Reynolds 1962, 1964, 1966; Terrel 1973); they conserve energy by this strategy. Travel to cover and seasonal migration to more favorable ranges increases the amount of energy required for maintenance (Holl et al. 1979, Moen 1973, Wallmo et al. 1977). Forage areas wider than 250 meters (820 ft) create less than optimum conditions (fig. 9); walking requires from 18 to 67 percent of the energy expenditures of deer, elk, and pronghorns (Moen 1973:358-361). Appropriate arrangements of forage areas, thermal cover, and hiding cover can minimize energy losses caused by exposure, travel, and anxiety (figs. 7 and 10 are stylized examples). Exposure to thermal stress is most severe in openings with diameters more than five times the height of adjacent cover, and energy drain from movement and tension associated with alertness also increase with distance to cover. The production of muscle, fat, and milk and prospects for survival all decline (fig. 4) when energy, protein, carbohydrates, fats, and minerals from forage do not surpass maintenance requirements (Blaxter 1962; Brody 1945, 1956; Holl et al. 1979; Moen 1973; Sadleir 1969).

A diversity of plant species tends to maintain forage quality and availability over the seasons and to provide a buffer against plant losses to diseases or insects. Digestibility and nutrient content of forage are controlled by phenological stages of growth, recognized by changes in plant form—bud burst, leaf expansion, stem lengthening, and flowering (Hickman 1975; Hormay 1943, 1956, 1970; Hyder and Sneva 1963; McIlvanie 1942; Subcommittee on Feed Composition 1969). Quality generally declines with weathering and from spring through winter. The phenologically young leaves of most species contain approximately equivalent high levels of digestible nutrients (Subcommittee on Feed Composition 1969). Some species attain that stage only in spring; others also produce nutrient-rich foliage in fall.

Figure 9. — Deer do not fully utilize forage areas that are more than 125 meters (410 feet) from cover.
Figure 10. — Centers of forage areas wider than 250 meters (820 ft), or 125 meters (410 ft) from cover edges, are used less than centers of smaller areas.





MINIMUM SIZE OF COVER: 91 m (300 ft.) WIDE
0.8 - 2 ha (2 - 5 ac)

Deer of all ages need high quality, succulent food to recover from weather stress, replenish body reserves, and grow and reproduce at optimum rates. This is especially important to nursing does. Young plant tissue is required because only in the early stages of growth does it contain an optimum balance and high concentrations of maximally digestible nutrients needed to produce muscle, fat, and milk.

Deer and other ungulates have foraging habits tied to their physiological requirements for survival and reproduction and adapted to cycles of plant phenology. They cope with declining forage quality by selecting plants and plant parts that are phenologically younger (Bell 1971; deBoer 1970; Holl et al. 1979; Hungerford 1970; Leach 1956; Leckenby 1968, 1969, 1978a, 1978c; Spalinger 1980:106); thus they need a diversity of forage plant species that reach equivalent phenological ages at different times. For example, Sandberg bluegrass begins leaf growth in late winter and has flowered by late spring; bluebunch wheatgrass does not begin growth until late spring and flowers in midsummer.

Because grazing and burning affect the phenology of forage plants, appropriate management can prolong the availability of high quality forage for mule deer (Anderson and Scherzinger 1975; Leckenby 1968, 1978c; Tueller and Tower 1979; Willms et al. 1979, 1980).

SPECIAL HABITAT NEEDS

Fawning and Fawn-rearing

Compact areas that contain a diversity of thermal cover, hiding cover, succulent forage, and water are needed by does during fawning and fawn-rearing (Reynolds 1974, Sheehy 1978, Stuth 1975). These areas become their activity centers during fawning in spring and remain central to their movements during the fawn-rearing period of summer.

Fawning habitat consists of vegetation stands used by does during birth and by newborn fawns for a brief sedentary period of about 1 week. Although fawning occurs in various habitats and farther than 1 mile from trees,[3] optimum fawning habitat is an area of low shrubs or small trees taller than .7 meter (2.2 ft), with at least 40-percent canopy closure, that lies within 50 meters (160 ft) of taller tree cover. It is located on slopes of 0 to 30 percent and within plant communities where forage is succulent and plentiful in June (Sheehy 1978) (fig. 11).

In ideal fawning habitat of 2 to 10 hectares (5 to 26 acres), a doe expends only a minimum of energy to meet her daily requirements. Surplus energy can then be transferred, through milk, into fawn growth (fig. 4). Water should be available within 600 meters (2,000 ft). Elder (1956) surmised that succulent forage meets only marginal water requirements. The farther a doe has to range from her fawn to satisfy daily requirements for water or food, the more energy she expends and the less energy she has for milk production. A reduced supply of milk decreases fawn growth and jeopardizes fawn survival. Absence of the doe from the area in which the fawn is concealed also increases the potential for predation since the doe is frequently too far away to protect the fawn.

Although one doe requires a relatively small area, habitat for several does fawning at the same time must be larger. When the density of animals in optimum fawning areas is high and cover patches are converted to forage areas, does may be forced to use suboptimal habitats or accept crowding. Crowding causes strife between does and their actions probably attract and help predators locate hiding fawns.

Fawn-rearing habitat may include the area used for fawning but is usually larger and more diverse (fig. 12). Optimum rearing habitat contains a diversity of plant communities and structural conditions in close proximity and assures that fawns maintain adequate growth rates as they depend more on forage and less on milk. Plant communities that satisfy hiding and thermal cover requirements are generally used from mid-morning until late afternoon. These characteristically contain a tree overstory with at least 50-percent canopy closure, and shrub or riparian communities more than 0.6 meters (2 ft) high with canopy closures of more than 23 percent. Shrub sites used during rearing are usually located within 100 meters (330 ft) of trees. Stands that do not provide thermal or hiding cover are infrequently used during the day; and are generally used for forage during morning and evening (Sheehy 1978). In most rangeland the need for thermal and hiding cover is greater than the supply.

[3] Nellis, C. Unpublished data on file at Idaho Fish and Game Department, Jerome, Idaho.

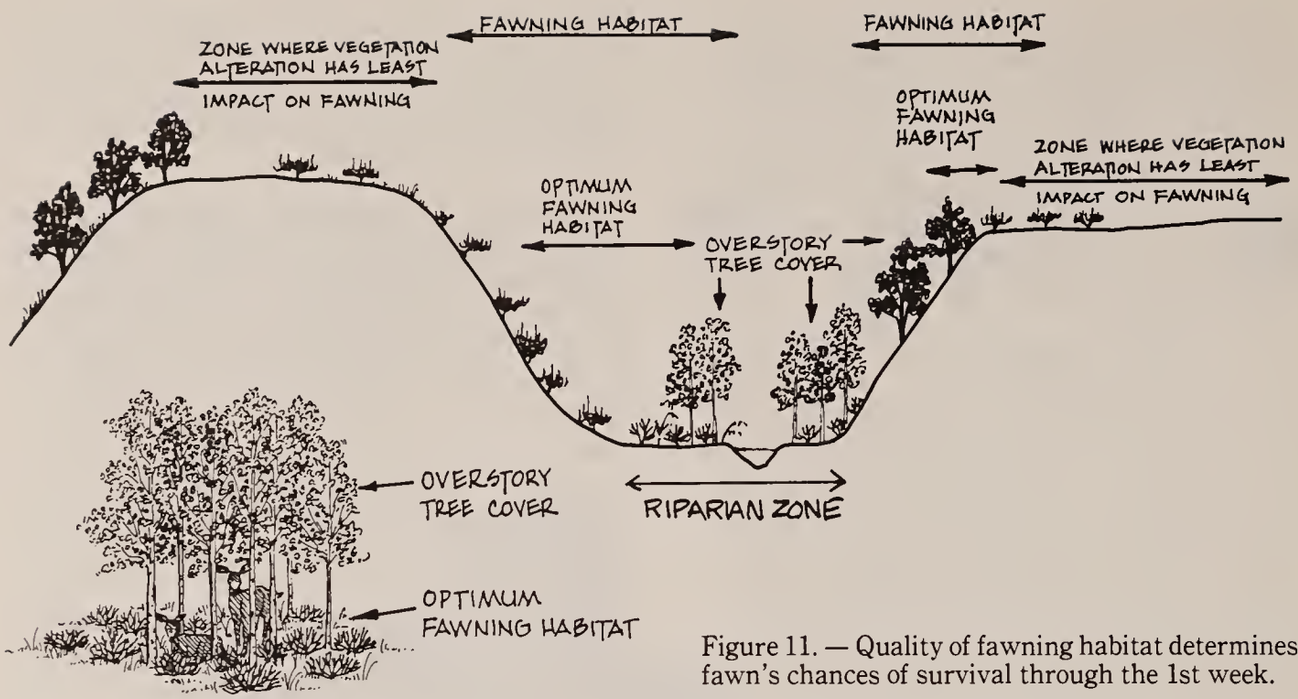


Figure 11. — Quality of fawning habitat determines a fawn's chances of survival through the 1st week.

Sheehy (1978) found that during the rearing period, fawns usually stayed within 1 kilometer (0.6 mi) of the fawning site. In the 1st month of life, movement averaged 0.6 kilometer (0.4 mi); thereafter single fawns moved less (0.5 kilometer or 0.3 mi) than twins, who moved 0.8 kilometer (0.5 mi). The optimum size for fawn-rearing areas appears to be about 160 hectares (395 acres). On Steens Mountain, in Harney County, Oregon, 90 percent of the fawn-rearing areas observed were this size or smaller; they ranged from 16 to 367 hectares (39 to 907 acres); the median was 81 hectares (200 acres). Twin fawns tended to occupy larger rearing areas than single fawns.

Fawn-rearing areas should not be regarded as independent units because there is considerable overlap in use of areas. It is important to identify and manage generalized fawn-rearing habitat rather than focusing on individual rearing areas.

Rehabilitation of fawning habitat may be desirable where stands appear decadent. Since control of shrubs replaces cover areas with forage areas, herd requirements and the probable impacts of reducing cover should be evaluated prior to treatment.

Proportion of Cover to Forage

We suggest that optimum mule deer range should contain a mixture of plant communities and structural conditions that provide areas of optimum size and spacing that add up to at least 55 percent forage areas, 20 percent hiding cover, 10 percent thermal cover, 10 percent fawn-rearing habitat, and 5 percent fawning habitat (fig. 13). On winter ranges where the option is available, thermal cover should be emphasized in place of habitat for fawning and fawn-rearing and up to 20 percent of the hiding cover, because thermal cover usually also provides hiding cover. A greater shift is not desirable because hiding cover contributes more to winter browse than thermal cover.

Success in managing habitat for mule deer should be measured in part by herd productivity. Goals for producing animals that survive in good condition and produce the desired number of fawns can be used to measure the success of habitat management in satisfying cover and forage requirements. Based on data adapted from another study (Leckenby 1978c, Leckenby and Adams 1978) an index of productive survival (PS) was estimated for four subpopulations of a herd near Silver Lake, Oregon. Productivity was estimated from a ratio of the maximum count of deer for each subpopulation to the population of the entire herd. Survival for each unit was estimated from the proportionate decline from fall to spring in the number of fawns per adult.

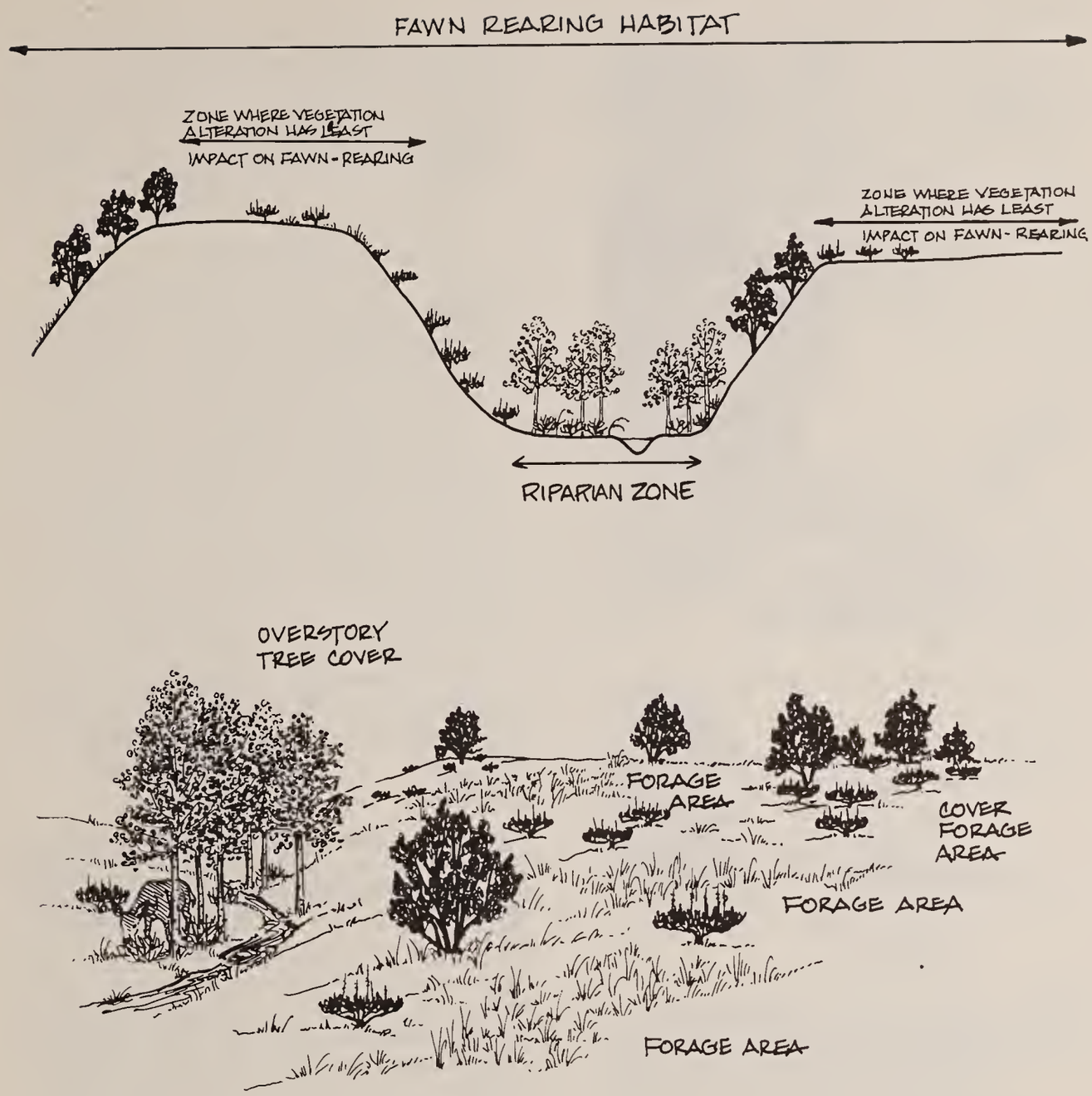


Figure 12. — Quality of fawn-rearing habitat determines the growth rate and survival of fawns through the 1st year.

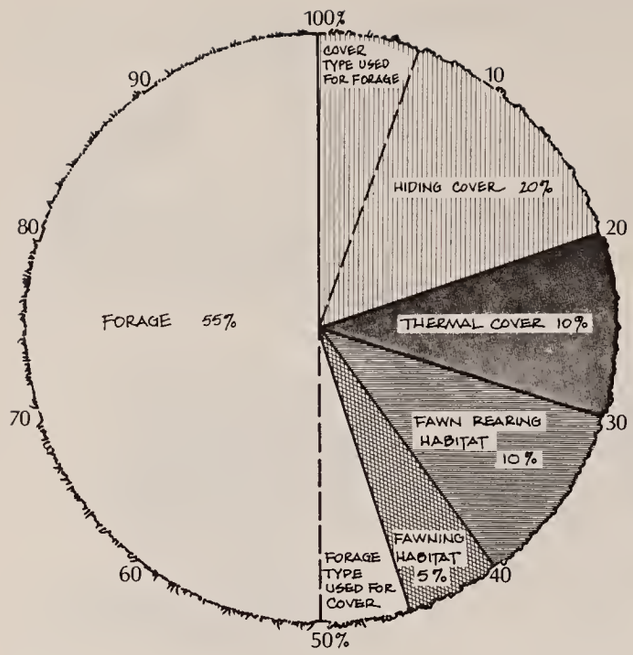


Figure 13. — Optimum mix of cover and forage for deer on shrub-steppe rangeland. Where there is a choice, thermal cover should be increased.

Calculation for each sample unit was as follows:

$$PS_i = (100)\ \frac{(d/ha/t)i}{\sum_{i=1}^{n} d/ha/t} + (100)\ \frac{1.0 - (f\text{-}s/f)i}{\sum_{i=1}^{n} 1.0 - (f\text{-}s/f)}$$

where: d is the maximum count of deer
ha is the area of a unit in hectares
t is the number of counting periods
f is the count of fawns per count of adults in fall times 100
s is the count of fawns per count of adults in spring times 100
i is a sample unit of the herd range

Comparison among the four subpopulation ranges, based on new analyses of data (Leckenby 1978c, Leckenby and Adams 1978) on the number of deer, amount of plant community use, number of fawns, and severity of weather suggest that maximum productive survival was attained

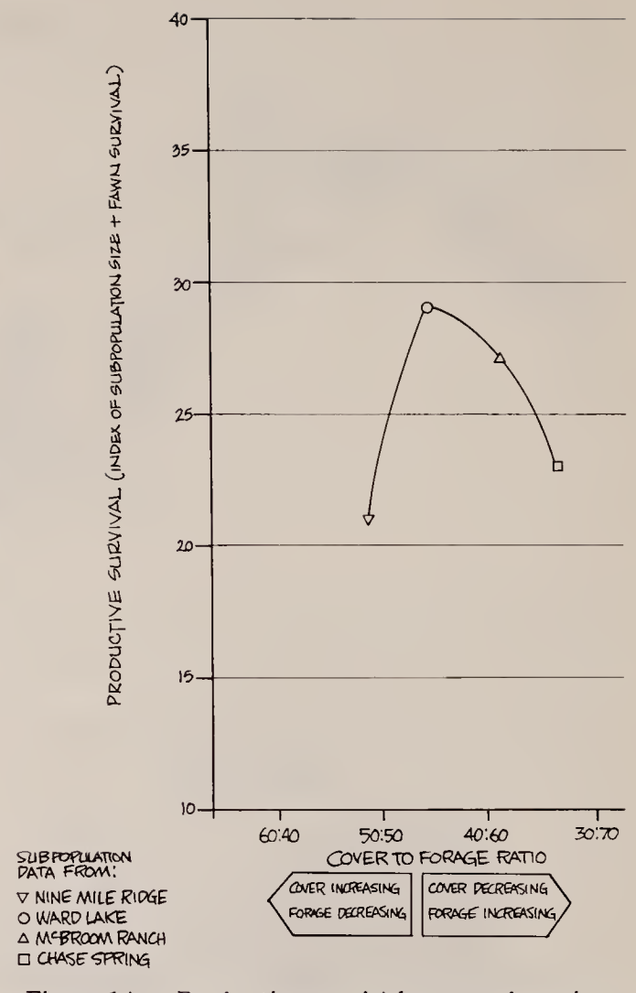


Figure 14. — Productive survival appeared maximum when cover areas made up 45 percent of mule deer winter range and forage areas made up 55 percent (adapted from Leckenby 1978c, Leckenby and Adams 1978).

where cover areas comprised about 45 percent of a subpopulation range (fig. 14). Ratios of cover to forage were computed independently from plant communities within each management unit.

Management actions that might shift the ratio of cover to forage should be based on both the total area that is currently occupied by each plant community and the area that may reasonably be expected to produce cover or forage within the usual treatment period.

A ratio of 40 percent cover to 60 percent forage appears to be consistent with proportions observed, estimated, or recommended by several authors who have studied deer herd ranges (Leopold et al. 1951:23, 129; Reynolds 1969a, 1972; Taber and Dasmann 1958:55; Terrel 1973; Thomas et al. 1979).

Riparian Zones

Because rangelands tend to be arid, streamsides, spring areas, and moist sites are important for mule deer. Riparian zones contain the only permanent or seasonal water and often enclose the most vegetationally productive sites found over long distances. They provide a diversity of plant species that usually offer good thermal and hiding cover and prolong the availability of succulent forage. They are especially important during fawn-rearing because supplies of basic needs are concentrated in them. The intense competition for cover, food, and water in riparian zones attests to their value (fig. 15), and unregulated use by livestock and people often reduces the availability of these resources to deer (Johnson and McCormick 1978, Owen 1980). Sheehy found that riparian vegetation was contained within every home range of fawns he observed.[4]

Water Sources

Although some studies suggest that deer require potable water for maximum production, others show that deer survive in regions where water sources are either far apart or seasonally intermittent (Dasmann 1971, Elder 1956). Numbers of deer fluctuate more in marginal habitat than on optimum ranges. We consider ranges less than optimum where water sources are farther than 320 meters (1,050 ft) apart.

Energy expended for travel to water reduces the amount available for survival or production. For example, a 68-kilogram (150-lb) doe would expend about the same amount of energy to walk 1 kilometer (0.6 mi) on level ground as she would use to produce 22 grams (0.7 oz) of milk or to raise a liter of water from 0°C (32°F) to her body temperature of 39°C (102°F). But she would use three times the amount of energy needed to walk that distance if water was not available and she consumed the equivalent as snow. These comparisons are calculated from estimates of the energy costs of walking on the level, producing milk, melting snow and heating water (Lange and Forker 1961:1539, 1549; Moen 1973:349, 354-356).

Figure 15. — Planning for riparian zones is singularly important. In them deer face increasing disturbance and competition from livestock and people.

[4] Sheehy, D.P. Personal communication. Information on file at Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

Various techniques for improving water sources or creating new ones have been developed to enhance habitat use and improve distribution and production of animals (Dasmann 1971, Yoakum and Dasmann 1969).

Management of Great Basin Plant Communities for Mule Deer

In this report, we have placed 28 plant communities of the Great Basin of southeastern Oregon in nine management groups, compared the characteristics of each with cover and forage requirements of mule deer, and contrasted unmanaged conditions with those induced by management practices. Dealy and others (1981) described the structural and floristic detail of the 28 plant communities. We identify communities by the species that dominate or characterize them (table 1). This method is used to save space; it does not indicate the importance of the identifying species to deer. Ecological requirements of each species present in a community provide information relevant to management of the site.

Where data from southeastern Oregon were lacking, we reviewed published information on the interactions of deer with cover and forage in similar plant communities for indications of relationships.

BIG SAGEBRUSHES

Although the various forms of big sagebrush (Beetle 1960, Hanks et al. 1973, Winward 1980, Winward and Tisdale 1977) differ in importance to mule deer, all are used for cover, forage, or both (Leckenby 1968, 1978c; Owen 1980; Sheehy 1975, 1978; Tueller and Monroe 1975).

Deer Use

The evergreen nature of big sagebrushes sustains their cover value throughout the year. Basin big sagebrush offers thermal and hiding cover because of its height, upright growth, and relatively dense crown. A tree-like form is often the result of livestock grazing. Mountain big sagebrush also forms good thermal and hiding cover because it usually has a dense canopy both vertically and horizontally, although it has a table-like form and does not grow as tall as basin big sagebrush. The close association of foothill big sagebrush with western juniper makes it somewhat less important as cover, although it can resemble the mountain form. Stands of Wyoming big sagebrush and alpine big sagebrush usually do not offer good hiding or thermal cover because of low height, low density, and open distribution.

Deer do not browse big sagebrush forms equally. Sheehy (1975) ranked their palatability as follows: foothill big sagebrush, good; mountain big sagebrush, good to fair; Wyoming big sagebrush, fair; alpine big sagebrush, poor; and basin big sagebrush, poor. Big sagebrushes generally receive greatest use in winter, moderate use in fall and spring, and lightest use in summer (Kufeld et al. 1973). Big sagebrush is more digestible when eaten in mixed diets than alone; but deer lose weight under winter weather conditions when fed only big sagebrush (Bissell et al. 1955, Dietz et al. 1962, Smith 1950). Yet, because they are evergreen, big sagebrushes are often the best available forage. Many plants associated with big sagebrushes are important deer forage (Kufeld et al. 1973).

Because of its form, palatability, and distribution, mountain big sagebrush offers optimum habitat for fawning and fawn-rearing within the shrub-steppe region (Sheehy 1978). The other big sagebrushes are used when they provide the best habitat available, but they are generally inferior to mountain big sagebrush.

Response to Management

Plans to manipulate big sagebrush stands to benefit mule deer must specify the plant community, the subspecies of sagebrush, the method of treatment, the size and arrangement of existing stands and proposed treatments, and the livestock grazing system.

Reducing big sagebrush cover can benefit deer in the following situations: (1) homogeneous blocks of big sagebrush wider than 380 meters (1,250 ft) which lack diversity within the grass-forb layer; (2) seasonal range where green forage is insufficient but cover is excess, such as at lower elevations where favorable exposure permits early greenup; (3) where big sagebrush is less desirable than meadow and riparian plant communities. Deer productivity can increase following reduction of big sagebrush, provided diversity, size of treatments, and cover-to-forage ratios are near optimum.

Table 1 — Habitat values and importance of plant communities for deer

Plant community and key plant	Elevation	Habitat value	Range	Importance[1]
Tall sagebrushes:				
Mountain big sagebrush	Above 3,500 ft (common)	Hiding and thermal cover (good), forage (fair), fawning (good), fawn-rearing (good)	Summer, winter, and spring-fall	1
Foothill big sagebrush[2]	Below 5,000 ft (limited)	Hiding and thermal cover (good), forage (good), fawning (fair)	Spring-fall	2
Alpine big sagebrush	Above 3,500 ft (limited)	Hiding and thermal cover (poor), forage (poor)	Summer	2
Wyoming big sagebrush	Below 6,500 ft (common)	Hiding and thermal cover (poor), forage (fair)	Winter	1
Basin big sagebrush	Below 7,000 ft (common)	Hiding and thermal cover (good), forage (poor)	Winter	1
Silver sagebrush	Above 4,000 ft (limited)	Hiding and thermal cover (fair or poor), forage (good)	Summer and winter	2
Short sagebrushes:				
Low sagebrush	Below 9,000 ft (common)	Hiding and thermal cover (poor), forage (good)	Summer, winter, and spring-fall	1
Stiff sagebrush	Below 7,000 ft (limited)	Hiding and thermal cover (poor), forage (fair)	Summer, winter, and spring-fall	2
Black sagebrush	Below 9,000 ft (limited)	Hiding and thermal cover (poor), forage (poor)	Summer and winter	3
Early low sagebrush	6,000 - 8,000 ft (limited)	Hiding and thermal cover (poor), forage (poor)	Spring-fall	3
Other shrubs:				
Bitterbrush	4,000 - 7,000 ft (common)	Hiding and thermal cover (good), forage (good)	Summer, winter, and spring-fall	1
Greasewood	Below 5,000 ft (common)	Hiding and thermal cover (poor), forage (poor)	Winter	3

Table 1 — Habitat values and importance of plant communities for deer, continued

Plant community and key plant	Elevation	Habitat value	Range	Importance[1]
Shadscale	Below 5,000 ft (limited)	Hiding and thermal cover (poor), forage (fair)	Winter	3
Snowberry	5,000 - 8,000 ft (limited)	Hiding and thermal cover (good), forage (good), fawning (good), fawn-rearing (good)	Summer and spring-fall	1
Snowbrush	Above 5,000 ft (limited)	Hiding and thermal cover (good), forage (good), fawning (good), fawn-rearing (good)	Summer	1
Chokecherry; bitter cherry	4,000 - 7,000 ft (limited)	Hiding and thermal cover (good), forage (good), fawn-rearing (good)	Summer	1
Willow	All elevations (common in riparian habitat)	Hiding and thermal cover (good), forage (good), fawn-rearing (good)	Summer	1
Squawapple	2,500 - 6,000 ft (limited)	Hiding and thermal cover (fair), forage (fair or poor)	Spring-fall and winter	2
Trees:				
Quaking aspen	5,000 - 9,000 ft (common in moist sites)	Hiding and thermal cover (good), forage (good), fawning (good), fawn-rearing (good)	Summer and spring-fall	1
Mountain-mahogany	5,000 - 7,000 ft (limited)	Thermal cover (good), forage (fair)	Summer and spring-fall	1
Mountain-mahogany/shrub	5,000 - 7,000 ft (limited)	Hiding and thermal cover (good), forage (good), fawn-rearing (fair)	Summer and spring-fall	1
Western juniper	Below 6,000 ft (common)	Hiding and thermal cover (good), forage (fair), fawn-rearing (fair)	Summer, winter, and spring-fall	1
Western juniper/shrub	Below 6,000 ft (common)	Hiding and thermal cover (good), forage (good), fawning (fair), fawn-rearing (fair)	Summer, winter, and spring-fall	1

Table 1 — Habitat values and importance of plant communities for deer, continued

Plant community and key plant	Elevation	Habitat value	Range	Importance[1]
Cottonwood	2,500 - 4,000 ft (limited riparian)	Hiding and thermal cover (good), forage (good), fawning (good), fawn-rearing (good)	Summer	1
Special communities:				
Riparian	All (limited)	Hiding and thermal cover (good), forage (good), fawning (good), fawn-rearing (good)	Summer, winter, and spring-fall	1
Grassland	All (common)	Forage (good, especially fall and spring greenup)	Summer, winter, and spring-fall	1 2
Bluebunch wheatgrass	All (common)	Forage (good, needs livestock grazing to maximize availability of new growth)	Spring, some fall, and winter	2
Idaho fescue	All (common)	Forage (good, needs livestock grazing to maximize availability of new growth)	Spring, some fall, and winter	2
Cheatgrass	All (common)	Forage (good)	Spring, fall, and winter	1
Crested wheatgrass	All (in treatment areas)	Forage (good, needs livestock grazing to maximize availability of new growth)	Spring, fall, and winter	1
Sandberg bluegrass	All (common)	Forage (good)	Spring, fall and winter	1
Bottlebrush squirreltail	All (common)	Forage (good, needs livestock grazing to maximize availability of new growth)	Spring, fall, and winter	2

[1] Importance to deer, based on habitat value and distribution: 1 high, 2 moderate, 3 least.
[2] Unrecognized variant of big sagebrush (Sheehy 1975).

Conversely, reducing the cover reduces deer productivity in the following situations: (1) where fawning and fawn-rearing habitat is limited; (2) on winter ranges with limited cover; (3) where big sagebrush provides the only cover, for example, big sagebrush islands or draws within expanses of scabland sageflats and big sagebrush around rimrocks in open desert; and (4) where riparian vegetation is not desirable or cannot be developed and big sagebrush provides a needed buffer zone of cover around springs and seeps.

Deer productivity can improve where big sagebrush cover is increased. Planting or management to favor its increase should be considered where there is a documented need; for example, creating islands of big sagebrush in vast areas of crested wheatgrass, or reestablishing a shrub layer in some juniper plant communities.

On many big sagebrush sites, herbaceous forage for deer can be increased by appropriate livestock grazing and by reducing shrub density and planting grasses and forbs (Koehler 1975, Plummer et al. 1968, Roberts 1975, Winward 1980). Cattle will eat standing dead grass. The subsequent regrowth of the shorter nutritious young leaves will then be more available to deer (Leckenby 1968, Willms et al. 1980). But when deer and livestock occupy seasonal ranges simultaneously they compete for forage. Deer select the new growth of grass, forb, and shrub species that are also eaten by cattle, sheep, horses, and goats. Separating livestock from deer by season of grazing or by fences is the key to reducing direct competition. Plant vigor is best maintained by grazing livestock during periods of plant dormancy. The next best management for plant vigor is to alternate short, intense grazing periods with periods of nonuse that coincide with soil moisture levels which allow regrowth and recharge of plant nutrients. Intensity of livestock grazing is important, but so is the season, duration, and frequency. The relative impact of these four grazing variables depends on how a grazing system interacts with the plant community (Hanley 1979). Livestock grazing can create tree-like cover in basin big sagebrush, but the cover value of other big sagebrush communities is reduced when their forage value is increased. Although observations indicate that mountain big sagebrush does not survive severe browsing as well as bitterbrush or mountain-mahogany, "hedging" effects of browsing by cattle on most shrub species may create a crown that is better protected from overuse by deer. In decadent stands of mountain big sagebrush, cattle grazing appears to stimulate plant reproduction by clearing away dead debris which retards seedling establishment.

SCABLAND SAGEBRUSHES

Several short sagebrush species (low sagebrush, early low sagebrush, black sagebrush, and stiff sagebrush) occupy harsh, rocky, shallow-soil scablands throughout the range of mule deer (Beetle 1960). These small sagebrushes provide little cover but offer forage of varying importance to deer (Leckenby 1968, 1978c; Sheehy 1978; Tueller and Monroe 1975).

Deer Use

Because of their small stature, short sagebrushes offer little thermal or hiding cover. Deer feed in the exposed habitats of short sagebrush scablands, principally during the mild weather of sunny, calm days in winter and near sunrise and sunset in summer.

The short sagebrushes are closely browsed throughout their distribution. In trials with deer and sheep, Sheehy (1975) ranked preference for low sagebrush as fair and black sagebrush as poor. Preference for stiff sagebrush is probably fair and may be seasonal because it is deciduous. Preference for early low sagebrush is probably fair and use may be influenced by its very early flowering and seed ripening (see footnote 4). Black sagebrush appeared to be slightly more digestible than big sagebrush, perhaps because of its small stems and leaves (Smith 1950). Sheehy (1975) measured digestibility of low sagebrush at 44.3 percent. Kufeld and others (1973) reported moderate use in fall, winter, and spring. Use throughout the year has been observed (Leckenby 1969).

In spring and early summer the forbs and grasses associated with short-sagebrush communities are important to deer. New growth is early and abundant in these scablands because the shallow, rocky soils warm quickly, especially on southerly aspects. Phenological development influences the timing of use by deer. Sandberg bluegrass, crested wheatgrass, and starved milkvetch are used very early, but migratory deer seldom have an oportunity to feed on bluebunch wheatgrass and curvepod milkvetch

because these plants normally initiate growth too late in the season. The immature stages of bluebunch wheatgrass, western needlegrass, and similar species are of value to nonmigratory deer, however, because their slower development provides digestible forage later in summer.

Although short sagebrush stands do not provide the cover essential for hiding and protecting fawns from predators and the elements, they are desirable in fawning and fawn-rearing areas since they often have abundant forbs and water during the early fawn-rearing period.

Response to Management

Present range treatment methods offer little potential for improving the cover value of scabland sites to mule deer. It is not practical to increase cover, although more cover would be beneficial. The sites are too harsh to support tall plants which could improve cover, and techniques for establishing them are not available.

Methods have not yet been developed for increasing deer forage on many short-sagebrush scablands (Winward 1980), but forb, grass, and browse composition of some stands has been improved by manipulation with fire, machinery, and chemicals. The shrubs can be eliminated and grasses emphasized by flooding, the management practice termed "water spreading," but this treatment decreases winter forage.

In stands of low sagebrush that appear to be dying because of competition with rank bunchgrass, livestock grazing could make the young growth of the grasses available to deer. Grazing would also tend to promote growth of low sagebrush browse.

Spring and early summer are times when livestock management can effectively modify forage production, but also times when competition between livestock and deer for forage is maximum. Periodic rest from grazing has to be adjusted to the early initiation of growth and late seed maturity of forbs in low sagebrush communities.

SILVER SAGEBRUSHES

Silver sagebrush communities are unique habitats that contribute to diversity and increase edge in areas dominated by tall sagebrush, short sagebrush, juniper, and pine communities. They are closely associated with drainage ways and basins. Beetle (1960) recognized at least two subspecies: a Bolander form that occurs in closed desert basins and a mountain form associated with riparian habitats. Leckenby (1978c) found that deer preferred Bolander silver sagebrush communities on winter range. Dealy (1971) considered mountain silver sagebrush communities of low value to deer on summer range.

Deer Use

The medium stature of silver sagebrush provides some hiding cover for mule deer, but plant density and canopy cover are usually low and offer little protection from weather.

Deer browse silver sagebrushes in fall, winter, and spring[5] (Kufeld et al. 1973). In browsing trials with captive mule deer, Sheehy (1975) found that Bolander silver sagebrush was one of the most preferred.

Site, phenology, and the availability and diversity of forage plants influence the degree and season of deer use of silver sagebrush basins. Lengthy spring flooding—normally up to a month—is characteristic of these communities and encourages lush growth of native forbs and grasses adapted to flooding. Associated forage plants that deer apparently prefer to sagebrush when they are available are muhly, Newberry's cinquefoil, Fremont combleaf, and other grasses and forbs in early growth stages. These are more nutritious than the older silver sagebrush browse.

Riparian zones dominated by mountain silver sagebrush communities provide fair cover and forage near water during much of the fawn-rearing period and are sufficiently valuable to mule deer to warrant protection. Persistent spring flooding, however, makes Bolander silver sagebrush communities unsuitable; after they dry, the flats are of little value for fawn-rearing because hiding cover, thermal cover, and forage are inadequate.

[5] Leckenby, D.A. Unpublished data on file, Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

Response to Management

Current techniques for manipulating habitat cannot increase the cover value of silver sagebrush communities and will decrease the little value they possess. The extremes of flooding and drying each year eliminate introduced shrubs which might otherwise provide increased cover.

Reducing cover, with or without soil disturbance, does increase forb and grass forage. Leckenby (1969) found that unusually long ponding significantly reduced Bolander silver sagebrush cover in closed basins in south-central Oregon for several years. This was followed by an increase in Newberry's cinquefoil and desert combleaf forage which was significant in the diet of mule deer through a mild winter. Most of the grasses and forbs planted to produce forage in range communities will not survive the inevitable spring flooding and summer drying in Bolander silver sagebrush stands (Leckenby and Toweill 1979a, Winward 1980).

Water holes and drainage ditches that are frequently dug in silver sagebrush basins quickly concentrate runoff water into deeper reservoirs. These retain water much longer than the wide, shallow ponds that collect water naturally and allow it to evaporate rapidly. Created water holes have an obvious positive benefit for wildlife and livestock, but they also have adverse impacts on wildlife. Some drain the basin so efficiently that big sagebrush and rabbitbrush are able to invade and replace the silver sagebrush.

Other methods have provided valuable water reservoirs without sacrificing the unique qualities of silver sagebrush communities. For example, "guzzlers" (catchment aprons with storage tanks) have been installed in adjacent expanses of tall and short sagebrush or western juniper.

Livestock grazing of mountain silver sagebrush stands can benefit mule deer by removing cured grass from summer range; however, this must be managed to protect plant vigor and prevent damage to the riparian zone. Competition between deer and livestock for forage is likely to occur in these riparian communities on summer range (Dealy 1971, Dusek 1975). We found that summer cattle grazing of silver sagebrush basins on deer winter range resulted in minimal competition but may have reduced plant vigor. Trampling of the associated moist clay soils in late spring and early summer compacted the soil and altered plant composition (Leckenby 1978c).

ANTELOPE BITTERBRUSH

Although it forms pure stands elsewhere (Daubenmire 1970, Nord 1965), antelope bitterbrush is usually one of several shrub species found in browse stands in the Great Basin. Managers have historically considered this species one of the most important deer browse plants in the West. Its stature, crown, form, and abundant fruit offer both obvious and subtle benefits for many species of wildlife. Its structural and foliage attributes greatly influence microclimate and provide cover and forage values associated with high levels of use by both deer and livestock (Hormay 1943, Leckenby 1978c, Tueller and Monroe 1975).

Deer Use

On many winter ranges, antelope bitterbrush provides exceptionally good hiding cover in both big and short sagebrush stands. Although deciduous, bitterbrush contributes to thermal cover on winter range because it is taller and has larger crowns than the sagebrushes, but it is not tall or dense enough to make good thermal or hiding cover under overstories of western juniper, ponderosa pine, and lodgepole pine on summer ranges.

Antelope bitterbrush is eaten by deer in all seasons, but major use occurs in late summer, fall, and early winter (Kufeld et al. 1973, Leach 1956, Leckenby 1969). Weather, seasonal moisture, and availability of other foods greatly affect browsing. Secondary peaks in use are noted during dry springs; following cool, moist summers major use may not begin until fall. Hormay (1943:3, 7) found that bitterbrush produces flowers and seed only on the previous year's wood and not on the current shoots. He also concluded that at least 40 percent of each year's current leader should remain following grazing. Adams (1975) and Hormay (1943) both suspected that declines in bitterbrush populations in Oregon and California had resulted from insufficient seed production caused by severe browsing.

Others have found that bitterbrush alone is not digestible enough to provide sufficient energy for maintenance under winter stress. For example, Dietz and others (1962) and Bissell and others (1955) found that deer fed bitterbrush alone or in combination with other browse species lost weight. Deer

usually seek foods more digestible and richer in energy than bitterbrush, such as young grasses and forbs, even when unused leaders of bitterbrush are abundant. When better forage is not available, however, deer browse bitterbrush severely, even clipping off 0.6-centimeter (¼-inch) diameter branchlets 2 to 4 years old[6] (Hormay 1943).

Because of their unusual density, height, and canopy closure, stands of antelope bitterbrush can provide good fawn-hiding cover; however, the usual ecological situation in which bitterbrush occurs (Nord 1965) does not assure fawn-rearing success because distances to water are usually too great, forbs and grasses mature rapidly, and temperatures are frequently extreme.

Response to Management

In most areas where bitterbrush forms a large part of communities important to deer, reducing cover has adverse impacts on deer productivity. On the other hand, where decadent shrubs are not producing as much forage as wildlife and livestock need, replacing older canopies with young-shrub crowns is beneficial. This requires either new plants or rejuvenation of old shrubs (Koehler 1975, Plummer et al. 1968). Grass and forb production can be increased without reducing bitterbrush cover by phenologically scheduled spraying of herbicides to control sagebrush and release the herbaceous layer.

Livestock grazing in bitterbrush stands in spring and early summer before soil moisture is depleted will benefit deer in fall and winter; livestock grazing in other seasons will cause direct competition with deer for forage and reduce plant vigor and reproduction; continuous grazing in summer and fall will magnify stress on plants. Unwise grazing management results in conditions which gradually alter the value of bitterbrush communities for wildlife and livestock as well.

To produce sufficient seed to continue bitterbrush stands, Hormay (1943:7) suggested that cattle be allowed to graze shrubs and shape them into more compact form that will protect shrubs from overuse and allow 15 to 20 percent of the new shoots to escape future browsing. He recommended one season of rest from cattle browsing every 4 or 5 years. Where bitterbrush is dying and not being replaced, we concluded that 2 years of rest would be needed to maximize seed production and perpetuate threatened stands. Hormay also found that height growth was restricted by cattle browsing, which prevented the shrubs from growing out of the reach of deer.

Cattle grazing can also be used to reduce competition of forbs and grasses for water and nutrients (Smith and Doell 1968, Tueller and Tower 1979). Livestock grazing in bitterbrush stands makes more forage available to deer by removing the cured foliage so deer can reach new leaves of grass. As a result deer rely less on bitterbrush for forage.

WESTERN JUNIPER AND JUNIPER/SAGEBRUSH

The pygmy forests — juniper woodlands of south-central and southeastern Oregon — are important to mule deer and other wildlife. They form habitats for deer which are analogous to the pinyon-juniper woodlands found elsewhere in the Great Basin and the Rocky Mountains (Holmgren 1972). During winter stress, western juniper communities were used more than any other type (Leckenby 1978a, Leckenby and Adams 1978). This woodland type comprises many communities. Juniper stands tend to be either predominantly young (40 to 80 years) or old (200 to 500 years) (Adams 1975). The structural components which juniper communities add to habitat diversity are apparently important to all aspects of deer use and range management on such sites (Leckenby and Toweill 1979a, 1979b; Reynolds 1972; Short et al. 1977; Tueller and Monroe 1975).

Deer Use

Western juniper stands provide excellent hiding and thermal cover for wildlife because they are short, dense-canopied, and evergreen. The arrangement and mixture of juniper in shrubland and grassland communities, however, is often less than optimum, a factor which probably contributes to the loss of some deer to weather stress and starvation, no matter how mild the winter. Better distribution of cover may be the

[6] Leckenby, D.A. Unpublished data on file at Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

reason some deer survive even the severest winters. Leckenby (1978c) found that in winter deer used juniper for thermal cover more than they used grassland forage areas or shrubland cover-forage areas. They also used juniper intensively for thermal cover on spring and fall ranges. Spalinger (1980) found they used juniper cover for bedding in Nevada.

Weather stress was 40 percent less under a young juniper stand with a 25-percent canopy closure than where canopy closure was 5 percent or less (Leckenby 1978a, Leckenby and Adams 1978). Young juniper stands generally make better hiding cover than thermal cover. They also provide more grass, forb, and shrub forage than older stands. As juniper stands age and develop larger crowns and greater canopy closure and crown depth, thermal cover is improved.

Deer use juniper in all seasons, particularly during stress caused by weather and food shortages. They will browse other forage if they have the chance, probably because juniper is not digestible enough to meet their energy needs during weather stress. Although chemical analysis of Utah juniper was similar to sagebrush (Smith 1952), it was less preferred than bitterbrush or mountain-mahogany. Juniper browse probably does not provide a maintenance diet but rather a survival diet.

Old juniper stands occupy harsh sites, and current management policies prevent development or renewal of other forage within such stands. Although forage plants do grow under juniper, they cannot sustain the same intensity and frequency of cropping by ungulates they do in other settings. Native forage plants grow better than most exotics, but seeds are not commercially available (Leckenby and Toweill 1979a, 1979b).

Western juniper can hide fawns, but the aridity of stands and their lack of succulent forage through the nursing period limit their value as fawn-rearing habitat. Their usefulness depends on forage in adjacent plant communities and availability of nearby water. Patches of juniper may be used for fawning and fawn-rearing as Sheehy (1978) found aspen patches were used within expanses of sagebrush.

Response to Management

Where juniper forms extensive, nearly monotonous stands of woodland various treatments can increase forage, edge, and diversity. Revegetation projects on sloping ranges should be restricted to corridors about 1 kilometer (0.6 mi) wide which lay across elevational contours. Projects on more level ranges should radiate from fawn-rearing areas and riparian zones. Habitat quality, defined by optimum sizes and distribution of cover and forage areas, edge distances, and diversity can be improved by appropriate cutting, chaining, and burning of units distributed within a larger project area. Such planning of treatment projects within management units is most compatible with ranges of deer subpopulations (Leckenby 1977, 1978a, 1978b).

Weather stress in the Great Basin makes thermal cover exceptionally important on all mule deer ranges. The vegetation influences on microclimates determine how much juniper communities can be manipulated while preserving thermal cover. Sizes of patches and distances between them must be considered.

Deer utilize forage better in smaller openings within juniper stands. Created forage areas, therefore, should be irregular, long, and no wider than 60 meters (200 ft), assuming an average juniper height of 6 meters (20 ft). Openings up to five tree heights in width allow wind speeds only 30 percent of speeds in areas where there is no cover at all (Geiger 1966). But compact openings smaller than recommended, increase turbulance in eddies which can exceed the speed of winds above the canopy (Bergen 1971, Geiger 1966, Gifford 1973). The long axis of forage openings should lie perpendicular to prevailing winds on winter ranges to minimize chilling and east-west on summer ranges for optimum shading. Temperature extremes in forage areas also vary with adjacent cover height (Bergen 1972, 1974; Cochran 1969; Geiger 1966; Moen 1968c, 1973).

The effectiveness of juniper cover depends primarily on structure and secondarily on how well stand sizes match the space required by social groups of deer. Juniper cover areas should be at least 91 meters (300 ft) wide to create adequate thermal protection and at least 183 meters (600 ft) wide to meet hiding requirements.

The latter dimension probably allows sufficient space for most social groups. Little additional effect or microclimate results when thermal cover stands are wider than three stand heights (Geiger 1966, Reifsnyder and Lull 1965). Wider stands, however, can accommodate more deer by providing enough preferred habitat to reduce conflicts between animals. Deer use increased in pinyon-juniper islands when 30 percent of treatment areas were retained in cover patches at least 152 meters (500 ft) wide, 10 hectares (25 acres) in size, and areas were no farther apart than 0.8 kilometers (0.5 mi) (Reynolds 1972).

Habitat diversity and structural qualities unique to juniper should be retained where stands comprise less than 40 percent of a management unit. Even though control techniques work better on larger junipers, it is not wise to concentrate treatment in older stands because recovery of their unique structural qualities will probably require several centuries.

The competition and seasonal availability of forage within juniper communities will indicate whether changes in livestock grazing or revegetation are necessary to provide additional forage. Manipulation of grazing intensity or season may enhance native forage by selective release. Several options are available when revegetation is selected as a way to increase forage (Koehler 1975, Plummer et al. 1968, Vallentine 1971). Planting forage species under standing juniper can increase spring forage without reducing cover (Leckenby and Toweill 1979b).

It is more difficult to attain a beneficial effect from livestock grazing in juniper stands than in most other habitats. On most sites, establishment and growth of deer forage is hindered by aridity, temperature extremes, shallow soils, and low fertility. The adverse impacts of severe grazing are prolonged by these harsh conditions. Although heavy livestock grazing in the past eliminated forage species in many stands, grazing can improve forage for deer if cattle graze coarse, mature plant parts. As always, requirements of forage plants must be satisfied before grazing is permitted. Livestock must be restricted to either those seasons when plants are dormant or when soil mositure levels will permit regrowth and recharge of plant reserves following grazing.

MOUNTAIN-MAHOGANY AND MOUNTAIN-MAHOGANY/SAGEBRUSH

The evergreen nature of mountain-mahogany and sagebrushes, which are regular community associates, make stands of these species important year around habitat for mule deer. The value of each stand is determined by composition and structure. Observed deer use of mountain-mahogany communities was very high for short periods in spring and fall and low, but consistent, in other seasons (Leckenby 1969, 1978c). Owen (1980), in multivariate analyses, found that bedding, moving, and feeding were primarily associated with structural characteristics of mountain-mahogany and other plant communities and secondarily with compositional characteristics. Tueller and Monroe (1975) found moderate to low densities of pellet groups in mountain-mahogany communities compared to other types.

Deer Use

Mountain-mahogany stands are generally short and canopies nearly closed. Cover values, therefore, are high throughout the year. These communities frequently grow in ecotones between timber and shrubland. Often they provide exceptional hiding and thermal cover close to forage areas, for example, where mountain-mahogany and short sagebursh communities adjoin.

Mountain-mahogany is browsed wherever it is found (Kufeld et al. 1973). The forage value of a particular stand depends primarily on community composition and condition, which reflect current and past grazing intensity. In most stands past use has been severe enough to create high browse lines, and the present forage value of mountain-mahogany communities is primarily in the associated shrubs, grasses, and forbs. The microclimate created by mahogany cover is thought to promote dense forbs and grasses (Owen 1980).

Excellent cover and usually good forage make mountain-mahogany stands potentially valuable habitat for fawning and fawn-rearing. But factors in adjacent areas, such as the availability of potable water and quality forage throughout the lactation period, determine their real value.

Patches of mountain-mahogany within expanses of shrubland may be focal points of fawning and fawn-rearing as Sheehy (1978) observed with aspen overstory.

Response to Management

Present knowledge of mountain-mahogany germination, establishment, growth, reproduction, and sprouting is limited (Dealy 1975). Thus, results of manipulating mahogany to increase cover and forage are unpredictable and often fail to meet treatment objectives. Management can reduce mountain-mahogany cover and produce more forage, but at the cost of habitat diversity. The present lack of understanding of the intensity of use by mule deer suggests that it is not wise to manipulate cover in stands of mountain-mahogany that are narrower than 90 meters (300 ft).

Severe browsing by deer and livestock has detrimentally affected many mountain-mahogany stands. On the other hand, livestock grazing on accumulated grass and forb litter in the understory can increase forage availability for deer. Grazing should be permitted only when plants are dormant. Numerous examples show that too much grazing, grazing at the wrong time, grazing at the same time every year, as well as too little grazing can all reduce forage availability.

SALT DESERT SHRUB: BLACK GREASEWOOD, SPINY HOPSAGE, AND SHADSCALE

Few mule deer utilize black greasewood, spiny hopsage, or shadscale communities. Although these communities provide sufficient hiding cover for bedded deer, thermal cover is poor, and most associated forage species are available for only short periods in early spring. Mule deer frequent the adjacent tall- and short-sagebrush communities much more. Where they are interspersed as small stands among expanses of sagebrush, the black greasewood, spiny hopsage, and shadscale communities improve habitat diversity and offer additional forage species, such as bud sagebrush and desert saltgrass. Salt desert shrub communities appear generally unimportant to deer management in this area.

NON-SHRUB COMMUNITIES, GRASSLANDS IN GENERAL

Bunchgrass communities, burned areas, seedings, and cheatgrass stands are considered together as nonshrub communities. Grasslands are not usually considered cover areas, but Nellis[7] has found that giant wildrye stands are used as fawn-rearing cover in Idaho. Grasslands adjacent to cover may provide valuable forage, depending on the interactions of stand size, grazing management, and season (Holl et al. 1979; Leckenby 1978c; Reynolds 1962, 1964; Tueller and Monroe 1975; Willms et al. 1979).

The interspersion of forage types, particularly as small areas within cover types, results in maximum effective use of forage by both deer and livestock. Forage was most intensively used around the edges of large (80 hectares or 200 acres) areas that had been seeded and burned, while average use over the entire stand was 40 percent.[8] In smaller stands (8 hectares or 20 acres) in the same area, 90 percent of available forage was used.[9]

Deer use was greater in small stands grazed by cattle in previous seasons. Deer grazed 80 to 96 percent of the grass plants, primarily crested wheatgrass, and removed 40 to 65 percent of the available spring growth in pastures grazed by cattle in the previous summer, but on pastures from which cattle had been excluded by fences, deer grazed only 16 to 20 percent of the grass plants and ate only 10 to 20 percent of the available spring growth (Leckenby 1968). Similar patterns of use by deer following cattle use were observed where range treatment or wildfire had produced grass stands dominated by bottlebrush squirreltail.

Nonshrub plant communities are most valuable to mule deer during fall, spring, and summer because of the lush green growth produced by

[7] Nellis, C. Unpublished data on file at Idaho Fish and Game Department, Jerome, Idaho.

[8] Bolstad, R. Unpublished data on file at Lakeview District, Bureau of Land Management, Lakeview, Oregon.

[9] Leckenby, D.A. Unpublished data on file at Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

precipitation in fall and ample soil moisture in spring. Fresh immature forage is high in nutrients, digestibility, and moisture and low in fiber, regardless of plant species (Subcommittee on Feed Composition 1969). Fall greenup permits deer to add to nutrient reserves before the stresses of winter. Rich and digestible new growth may also increase ovulation rates. Spring and early summer greenup supplies quality forage at a critical time when body reserves are nearly depleted, fetuses are growing rapidly, does are lactating, and deer are migrating.

SPECIAL PLANT COMMUNITIES

The Great Basin contains additional plant communities that are unique or different from the majority of habitats in the area. They are especially important to deer because they are limited in extent and because they provide valuable habitat within expanses of less hospitable habitat or satisfy deer needs during certain times of the year. They include riparian zones, pine and fir forests, and aspen, squawapple, snowbrush, snowberry, chokecherry, and bitter cherry communities. Management of these environments requires especially careful evaluation, and maintenance is often the best choice.

Riparian

Riparian zones are especially valuable for fawn-rearing, summer and winter thermal cover, and late season forage. Willow, dogwood, cottonwood, and other characteristic riparian plant communities provide concentrations of what Leopold (1933:29) called welfare factors — cover, food, and water. Because of these factors, riparian zones are often centers of intense competition among wildlife, livestock, and people. Agricultural activities, housing subdivisions, and recreational developments reduce habitat and increase conflicts. Mule deer are subject to more frequent and more intensive disturbance in riparian communities than in any other habitat throughout the Great Basin. Any development or overuse of riparian zones reduces their value as deer habitat.

Pine and Fir Forest

Pine and fir forest types are limited in the Great Basin and are generally restricted to relict stands in unique situations. Because seed sources are isolated, environments are harsh and exacting, successional stages are persistent, and tree growth is slow, these forests will probably not respond to management practices in the same manner recommended for other forested areas (Thomas et al. 1979). The foregoing factors make these forests ecologically much different from the pine and fir stands elsewhere — in the Blue Mountains, for example. Management proposals to manipulate or exploit these environments require careful evaluation. The precarious existence of these stands, their small size, their unique contributions to habitat diversity, and their importance to wildlife suggest that management to perpetuate and preserve them has a far sounder basis than management for timber production or livestock forage.

Aspen

Quaking aspen communities add considerably to the beauty and diversity of the Great Basin shrub-steppe and are second only to riparian zones in importance to mule deer. They provide extremely valuable cover and forage during fawning and fawn-rearing (Sheehy 1978). They also provide patches of valuable hiding and thermal cover within expanses of sagebrush. They contain grasses, forbs, and shrubs that provide good summer and autumn forage (Smith et al. 1972). Snowberry, for example, is a common and important browse component of these stands.

Competition between mule deer and livestock for aspen habitats is high because of the excellent cover and forage they provide. Alteration of cover and severe grazing within these communities can have adverse impacts on deer. Severe browsing of aspen sprouts appears to limit regeneration of the overstory and probably results from the competition for forage and space (Smith et al. 1972). While removal of aspen is usually detrimental to the welfare of mule deer, the value of decadent stands may be improved by prescribing burning, cutting, and grazing management (DeByle 1978, Patton and Jones 1977, Reynolds 1969b, Smith et al. 1972). Aspen stands should receive special evaluation during planning.

Squawapple

Squawapple communities provide cover and forage for mule deer. Associated grasses and forbs are particularly valuable during early spring growth. These plant communities are often semi-riparian, occurring in moist swales in association with scabland vegetation types. Their value is heightened because of their association with adjacent communities that are deficient in cover. Like riparian zones, squawapple communities are focal points for competition between livestock and deer, especially in late spring. Nearby conifer stands often provide fawning habitats. The stands should be managed to enhance their cover and forage attributes while maintaining their contribution to habitat diversity of rangelands.

Snowbrush

The stature, form, density, and evergreen nature of snowbrush make it particularly valuable to deer in all seasons. It quickly invades burns and establishes large forage areas. It is important in summer and fall diets (Leach 1956). In late summer, fall, and winter, the evergreen foliage is more nutritious than stems of many deciduous browse species. On productive sites, within 10 years after burning snowbrush will produce a canopy of adequate height and closure to provide thermal and hiding cover on summer and spring-fall ranges. On sites near intermittent or permanent water, the thermal and hiding cover provided by snowbrush communities can be excellent [10] (Sheehy 1978).

Since snowbrush quickly becomes tall and dense on good sites, optimum production and availability of understory plants lasts only a few years. Prescribed burning can perpetuate cover and forage diversity over extended periods (see footnote 10). Burning is necessary to break seed dormancy and regenerate snowbrush; mechanical and chemical treatments do not create adequate cover or forage stands as quickly as fire.

[10] Grogan, F. Oregon Department of Fish and Wildlife, Lakeview, Oregon. Personal communication. Information on file at Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

Snowberry

Communities dominated by snowberry are neither extensive nor common in the Great Basin. Where they occur, however, they are intensively used by mule deer. They tend to be associated with specific plant habitats, such as stands of wax currant and big sagebrush on rimrocks and quaking aspen in moist locations.

Cover values of snowberry communities are generally moderate to low, although in some areas they provide excellent hiding cover. Snowberry types are used by deer as cover from spring through fall (Sheehy 1978).[11]

Snowberry is browsed the year around. Use is generally greatest in late summer and early fall but is also high in late spring at lower elevations. Spalinger (1980:123) conjectured that snowberry may be more valuable than digestion trials indicate.

Manipulation of snowberry communities in the Great Basin is detrimental to mule deer and other wildlife. This is especially true where these communities occur on rimrocks or aspen sites and provide the only diversity in uniform stands of big sagebrush.

Chokecherry and Bitter Cherry

Stands of wild cherry species are like quaking aspen communities in many respects. They grow on moist sites in rich shrub, forb, and grass communities that often retain phenologically young forage species longer than adjacent communities and provide important mid- to late-summer habitats. These plant associations add considerable diversity to rocky rims, stream canyons, and grassland slopes in many areas. Wild cherry communities are often used intensively by livestock because they provide mild microclimates and the resulting competition with deer for space and forage is often substantial.

Chokecherry and bitter cherry, like aspen, can provide excellent thermal and hiding cover from spring through summer. Stands vary considerably in density, but spread by suckering tends to create dense irregular patches that provide cover favorable to deer.

[11] Nellis, C. Unpublished data on file at Idaho Fish and Game Department, Jerome, Idaho.

Although used all year, wild cherry species are browsed most intensively in fall and spring, and deer regularly consume the ripe fruit. Associated forbs also provide excellent summer forage.

Because the stands are limited and important, and since current management techniques cannot improve the cover and forage qualities of these communities, maintenance is the best management.

Management Tips

1. Habitat management units should not exceed 4 700 hectares (11,500 acres). They should be parallel to primary drainages and ridges. On ranges with an average slope of more than 2 percent, units should be about 5 kilometers (3 mi) wide and no more than 10 kilometers (6 mi) between upper and lower elevations. On level ranges, units may approximate squares, 8 kilometers (5 mi) on all sides, or circular areas with a radius of 4 kilometers (2.5 mi).

2. Because livestock is usually the major product of managed rangelands, grazing provides the most economical tool for manipulating forage over large areas. Grazing systems can be used to manipulate vegetation and provide for all needs of deer. This requires careful planning of sizes and boundaries of pastures and rotation schedules adapted to deer subpopulation areas and seasonal movements. The usual system of rotating three or four large pastures does not allow rest periods tailored to the physiological requirements of browse species and may not leave enough forage in an intensively grazed pasture that encompasses the range of a deer subpopulation. If only lightly grazed or rested pastures encompass the range of a subpopulation, then adequate new growth of grasses will not be available. A four- to six-pasture system that includes rest and rotation may be needed to maintain or enhance preferred browse species, such as bitterbrush.

3. Riparian zones are of great importance to desert mule deer. They satisfy requirements for cover, food, water, and plant species diversity in a small space. Management of these zones requires extremely careful planning, based on comprehensive analysis of a multitude of variables (fig. 16). It is difficult to implement a livestock grazing system that will adequately protect unfenced

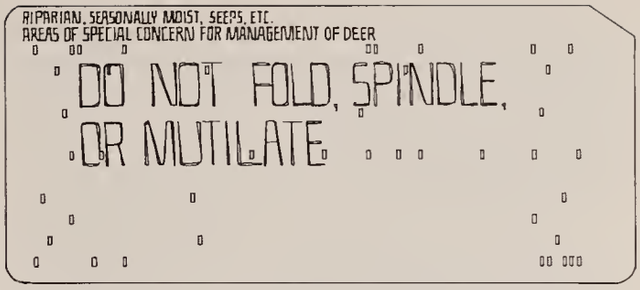


Figure 16. — Computer techniques are helping to store and analyze data to assist managers in understanding the importance of managing riparian zones with sensitivity appropriate to their high value as habitat for deer, livestock, and people.

riparian vegetation (Duff 1979, Olson and Armour 1979, Storch 1979), but management has reversed vegetation trends and deterioration on some sites (Behnke and Raleigh 1978). Reductions in stocking may not produce the desired results, since cattle tend to concentrate in riparian zones during summer and fall and use streamside vegetation intensively. Some livestock use of riparian areas may be beneficial, however, since livestock tend to break down or thin out streamside growth that becomes too thick for deer movement or browsing. Classification of riparian zones by elevation would associate zones with summer, winter, and spring-fall ranges and help managers develop grazing systems compatible with the seasonal needs of deer.

4. In units where deer depend on livestock watering devices, such devices should remain in operation after the livestock grazing season. Overflow water piped from troughs into managed pastures or livestock exclosures can promote forage for deer and cover for other wildlife. The benefits from such water management must be balanced against loss of cover provided by juniper and sagebrushes, which are intolerant of soil saturation.

5. Most vegetation conversions replace cover and browse with livestock forage, chiefly exotic grasses. Such treatments can reduce deer use through loss of cover and winter forage. Grass monocultures wider than 366 meters (1,200 ft) are poor deer habitat. Removal of woody, nonforage species is not always desirable because they may provide thermal and hiding cover for deer. Good deer range requires a mixture of grass, forbs, browse, and cover species.

6. Vegetation improvement projects to benefit mule deer should be implemented only after five conditions have been met:

(a) Biological data show a need for range improvement.
(b) Moderate techniques, such as changes in livestock grazing or herd size, have not improved conditions.
(c) Plant communities have been identified.
(d) The probability of attaining project objectives on that site within a reasonable time is high.
(e) Effects on ecosystems and probable future land uses and management options have been evaluated.

7. The success of habitat rehabilitation projects should be measured by impacts on all resources, as well as costs of treatment.

8. Size of areas to be treated by plowing and seeding or other programs should be selected to produce the appropriate ratio of cover to forage, desired plant diversity, and optimum amount of edge. If range treatment includes seeding, native and adapted exotic plants should be selected to maintain a diversity of green, succulent forage over as long a time as possible.

9. Since forage productivity declines when plant requirements are not met, managers need to be as concerned with the amount of herbage left at the end of the growing season as they are with the amount consumed by deer and livestock.

10. Forage should be allocated to deer on the basis of:

(a) season of use;
(b) seasonal availability;
(c) seasonal nutrient requirements;
(d) number of deer planned for, by sex and age classes;
(e) conversion of available forage to deer unit months, a measure similar to animal unit months (AUM) but also accounting for overlap of diet and season and area of range use.

11. Management practices that encourage human use of mule deer habitat should be carefully planned so that uses are compatible.

Conclusion

Flexibility in managing public rangelands to keep pace with society's changing demands for products is dictated by laws, such as the Forest and Rangeland Renewable Resources Planning Act of 1974 sec 2(3). As public land administrators prepare to manage all rangeland resources as intensively as they currently manage livestock, livestock management will evolve into range management, and habitat for wildlife will be maintained, increased, and enhanced. Management of range ecosystems will include refinements that account for impacts of old uses as well as new ones, as land managers decide which resources are to be emphasized and the intensity of management to be applied. Although the flow of products from most rangelands can be sustained, with more careful planning, more detailed inventories, and tighter management, we can meet the constraints of shrub-steppe ecosystems and reap additional benefits. The trick is to make management decisions that maintain harmony among natural interrelationships and human goals.

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Appendix

Common and Scientific Names of Plants[1]

Name in text	Scientific name
Antelope bitterbrush	*Purshia tridentata*
Basin big sagebrush	*Artemisia tridentata tridentata*
Big sagebrush	*Artemisia tridentata*
Bitter cherry	*Prunus emarginata*
Black cottonwood	*Populus trichocarpa*
Black greasewood	*Sarcobatus vermiculatus*
Black sagebrush	*Artemisia nova*
Bluebunch wheatgrass	*Agropyron spicatum*
Bolander silver sagebrush	*Artemisia cana bolanderi*
Bottlebrush squirreltail	*Sitanion hystrix*
Bud sagebrush	*Artemisia spinescens*
Cheatgrass brome	*Bromus tectorum*
Common chokecherry	*Prunus virginiana*
Crested wheatgrass	*Agropyron desertorum*
Curvepod loco	*Astragalus curvicarpus*
Desert combleaf[2]	*Polyctenium fremontii*
Desert saltgrass	*Distichlis stricta*
Dogwood	*Cornus stolonifera occidentalis*
Early low sagebrush	*Artemisia longiloba*
Foothill big sagebrush[3]	*Artemisia tridentata* form *xericensis*
Giant wildrye	*Elymus cinereus*
Idaho fescue	*Festuca idahoensis*
Lodgepole pine	*Pinus contorta*
Low sagebrush	*Artemisia arbuscula arbuscula*
Mountain big sagebrush	*Artemisia tridentata vaseyana*
Mountain-mahogany	*Cercocarpus ledifolius*
Mountain silver sagebrush	*Artemisia cana viscidula*
Muhly	*Muhlenbergia richardsonis*
Newberry's cinquefoil[2]	*Potentilla newberryi*
Pinyon[4]	*Pinus edulis,* and *P. monophylla*
Ponderosa pine	*Pinus ponderosa*
Quaking aspen	*Populus tremuloides*

Appendix

Common and Scientific Names of Plants[1]

continued

Name in text	Scientific name
Sandberg bluegrass	*Poa sandbergii*
Shadscale	*Atriplex confertifolia*
Snowberry	*Symphoricarpos albus,* and *S. oreophilus*
Snowbrush	*Ceanothus velutinus*
Spiny hopsage	*Grayia spinosa*
Squawapple	*Peraphyllum ramosissimum*
Starved milkvetch	*Astragalus miser*
Stiff sagebrush	*Artemisia rigida*
Subalpine big sagebrush	*Artemisia tridentata spiciformis*
Utah juniper[5]	*Juniperus utahensis*
Wax currant	*Ribes cereum*
Western juniper	*Juniperus occidentalis*
Western needlegrass	*Stipa occidentalis*
White fir	*Abies concolor*
Willow	*Salix* spp.
Wyoming big sagebrush	*Artemisia tridentata wyominensis*

[1] Scientific and common names are from Garrison et al. (1976), except as noted.
[2] Hitchcock and Cronquist (1973).
[3] Sheehy (1975).
[4] Holmgren (1972).
[5] Smith (1952).

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Bighorn Sheep

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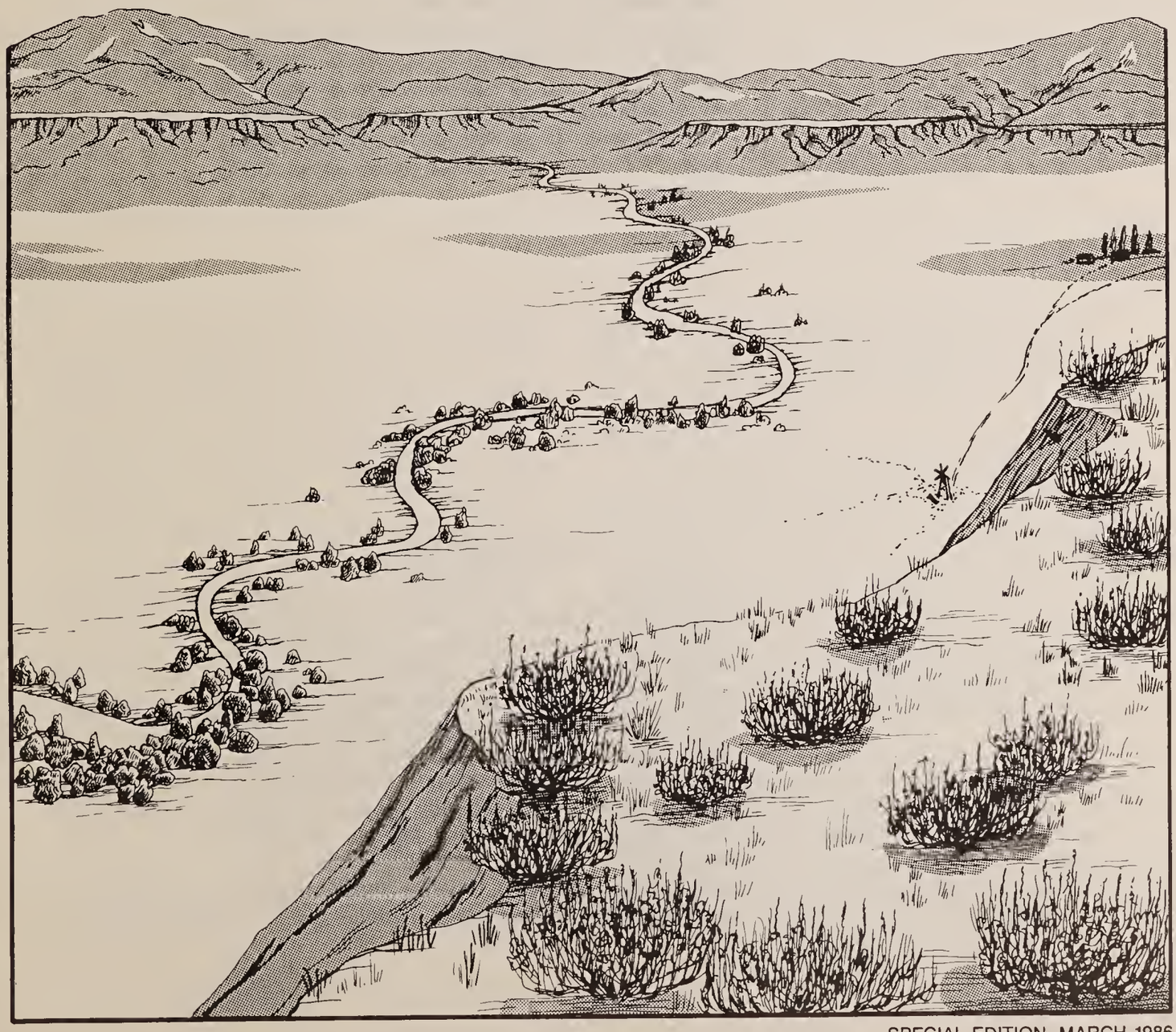
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Bighorn Sheep

Walter A. Van Dyke, Alan Sands, Jim Yoakum, Allan Polenz, and James Blaisdell



SPECIAL EDITION, MARCH 1986

Abstract

Habitat in southeastern Oregon that was used by California bighorn sheep until about 1916 can be managed to maintain herds that have been reintroduced into the area and to accommodate additional herds. Survival and productivity are enhanced by management based on an understanding of the animal's needs. These include appropriate interspersion of adequate water, forage, and escape terrain, lack of competition with other grazing ungulates for food and water, and absence of disturbance.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Bighorn sheep[1] were once abundant throughout Western North America. Since 1900, however, they have declined in most areas (fig. 1) and many populations have been eliminated (Buechner 1960, Wagner 1978). Population declines have been attributed to hunting, to parasites and disease, and to competition with domestic livestock for forage, and with humans for space (Buechner 1960, Davis and Taylor 1939, Honess 1942, Honess and Frost 1942, Packard 1946). Wildlife agencies in the western regions of Canada, the United States, and Mexico have initiated programs to maintain or enhance existing populations of bighorn sheep and to reintroduce them into historic ranges (Spalding and Mitchell 1970, Trefethan 1975). But, unless there is better land management, a decline of 8 percent can be expected in the next 25 years on land managed by the Bureau of Land Management (BLM), U.S. Department of the Interior (Jahn and Trefethen 1978).

In the Great Basin the situation is somewhat different. Although some transplant attempts have failed (Trefethan 1975), the States have been successful in reintroducing bighorn sheep into some historic ranges (Trefethan 1975, Yoakum 1973).

Three subspecies of bighorn sheep were endemic to the Great Basin in the past: Rocky Mountain, California, and desert bighorns (Bailey 1936, Buechner 1960, Cowen 1940, Hall and Kelson 1959, Seton 1929). The California bighorn sheep, indigenous to the southeastern Oregon portion of the Great Basin, disappeared around 1916 (Bailey 1936). As a result of transplants, the area again has several populations of California bighorn sheep (Trefethan 1975). If these once-native sheep are to remain, it is essential to maintain or enhance habitats that meet their biological requirements.

Bighorn sheep have evolved unique social and behavioral traits. They occupy traditional ranges and are slow to pioneer new habitats (Geist 1971). This means that careful manage-

[1] Scientific and common names and their sources are listed in the appendix.

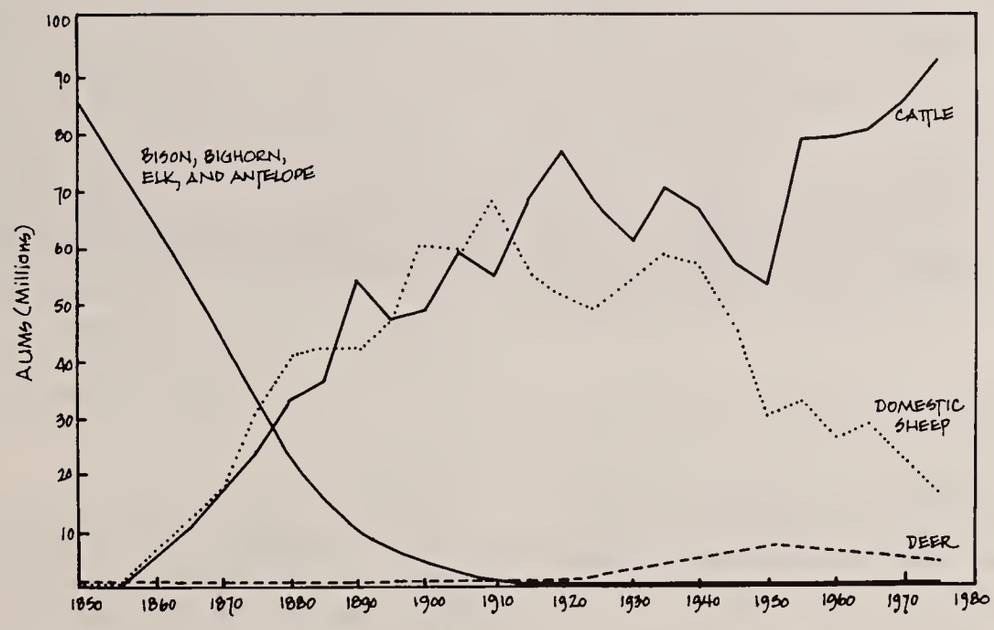

Figure 1.—Grazing of wild ungulates has declined in the western United States since 1850 while grazing of domestic ungulates has increased (redrawn from Wagner 1978:137).

ment of the habitat of existing herds is critical. Much habitat used by herds in the past is publicly administered and is suitable for additional transplant attempts (Yoakum 1971, 1973). Some publicly administered habitat, however, is now unsuitable because of past abuse (McCutchen 1981). Management techniques are available to make these areas again suitable for bighorn sheep, and interim management should not preclude opportunities to reestablish herds in the future.

Our purpose is to help land and wildlife managers evaluate, maintain, and enhance habitat for bighorn sheep by providing information that will enable them to: (1) recognize potential habitat on the basis of geomorphic features and plant communities; (2) predict the consequences of management actions; and (3) select appropriate management alternatives.

Information in this chapter was developed specifically for California bighorn sheep habitat in the Great Basin of southeastern Oregon. Few scientific studies of bighorn sheep habitat and management have been made in that part of the Great Basin. Consequently, we have used some information from other areas of the Great Basin or from other regions. Because such studies have frequently dealt with the desert or Rocky Mountain subspecies, the information presented here should have application to all bighorn sheep, with appropriate local adjustments.

We have made the following assumptions:

1. Extensive areas of historic habitat, presently unoccupied by bighorn sheep, can support herds or can be made capable of supporting herds.

2. Land uses can be tailored to provide areas of sufficient size to maintain viable populations.

3. Where there are conflicts between bighorn sheep and other ungulates for forage, water, or cover on public land, it may be necessary to give priority to bighorn sheep.

4. The information presented here is concerned with maintaining natural populations of free-ranging wild sheep; we are not addressing situations where populations can be maintained only by artificial means.

Characteristics of Habitat

Bighorn sheep generally inhabit remote, steep, rugged terrain, such as mountains, canyons, and escarpments where precipitation is low and evaporation is high (fig. 2). Plant communities are usually low and open in structure and stable, at or near climax. Sagebrush/grassland steppes and cold desert shrublands are the dominant types.

Bighorn sheep ranges in southeastern Oregon include several plant communities (Dealy et al. 1981) that reflect variations in elevation, slope, aspect, soil type, and precipitation (fig. 3). Summer ranges vary from subalpine meadows or grasslands at elevations above 2 287 meters (7,500 ft), to sagebrush/grasslands or shrublands that are dominant at elevations above 1 220 meters (4,000 ft). Winter ranges are usually below 1 830 meters (6,000 ft) and are characterized by shrub/grasslands or shrublands. Communities dominated by trees or tall shrubs such as aspen, cottonwood, fir, pine, juniper, mountainmahogany, squaw apple, and cherry, may occur throughout both summer and winter ranges, but there are no large densely forested areas.

Some bighorn sheep herds are year-long residents on a given area, with little or no spatial separation of summer and winter ranges (Blood 1963a, Drewek 1970, Demarchi and Mitchell 1973, Haas 1979, Kornet 1978, Van Dyke 1978). Other herds migrate several miles between summer and winter ranges and occupy areas that include a variety of elevations and environmental conditions (Blood 1963a, Geist 1971, Shannon et al. 1975). Both summer and winter ranges must provide freedom from disturbance and a proper juxtaposition of forage, escape terrain, and water if viable populations are to be maintained.

The major needs of bighorn sheep are: forage, water, thermal protection, and areas for escape, rutting, and lambing. If forage, water, and escape terrain are available, varying amounts of thermal protection will also be provided and rutting and lambing will normally occur. There are, however, cases where bighorn sheep move to particular areas to rut or lamb (Geist 1971, Kornet 1978). Management should not interfere with this movement.

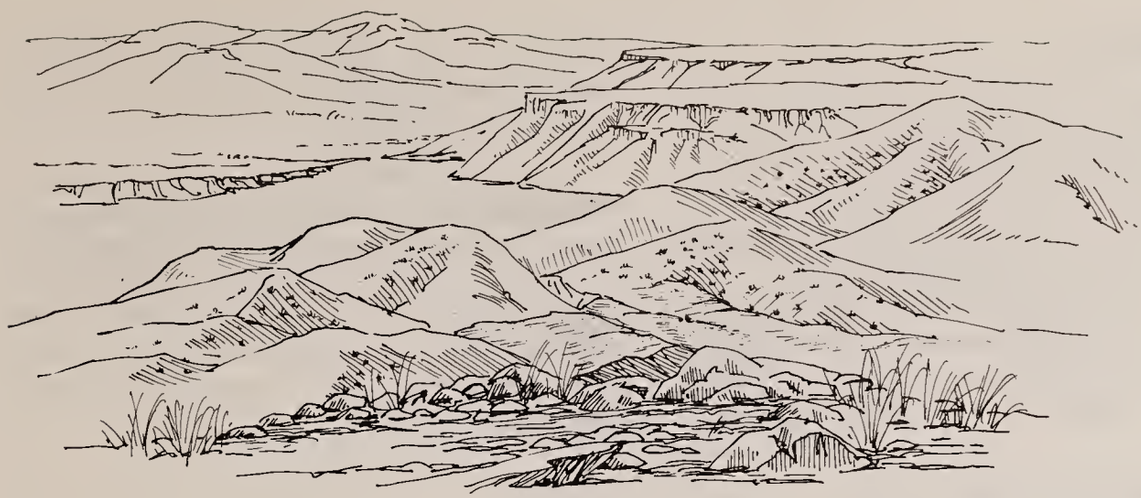

Figure 2.—Mountains, canyons, and escarpments provide bighorn sheep habitat.

Figure 3.—An example of bighorn sheep habitat in southeastern Oregon (photo by Walt Van Dyke).

ESCAPE AREAS

Cliffs, rock rims, rock outcroppings, and bluffs typify escape habitat, which is primarily used for bedding (Davis and Taylor 1939, Hailey 1971, Hansen 1980, Kornet 1978, Van Dyke 1978) and for escape from perceived danger (Frisina 1974, Geist 1971, Hansen 1980, Leslie and Douglas 1979, Woolf 1968). Steep broken cliffs with traversable terraces are desirable; sheer, vertical cliffs are not (fig. 4). Where cliffs are lacking, steep slopes are used for escape (Demarchi and Mitchell 1973). Unstable geomorphic features such as talus are also used for escape and bedding.

We have no specific data on sizes of cliffs suitable for bedding and escape areas. We have estimated minimum size requirements on the basis of criteria provided by Maser et al. (1979). The importance of cliffs varies with size (fig. 5). For example, cliffs that provide thermal cover, bedsites, and escape terrain may not be large enough for lambing.

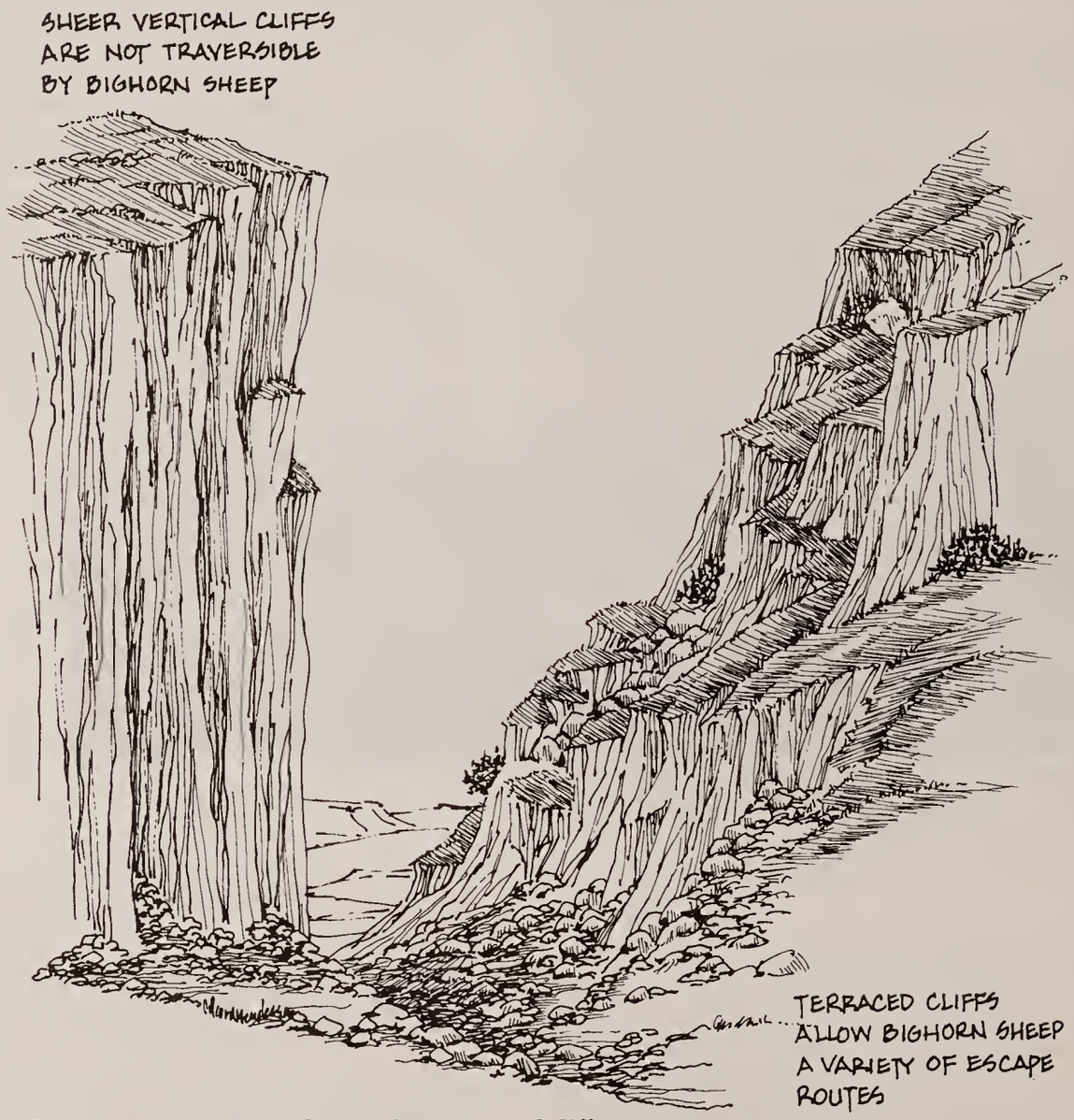

Figure 4.—Comparison of vertical and terraced cliffs as escape terrain for bighorn sheep.

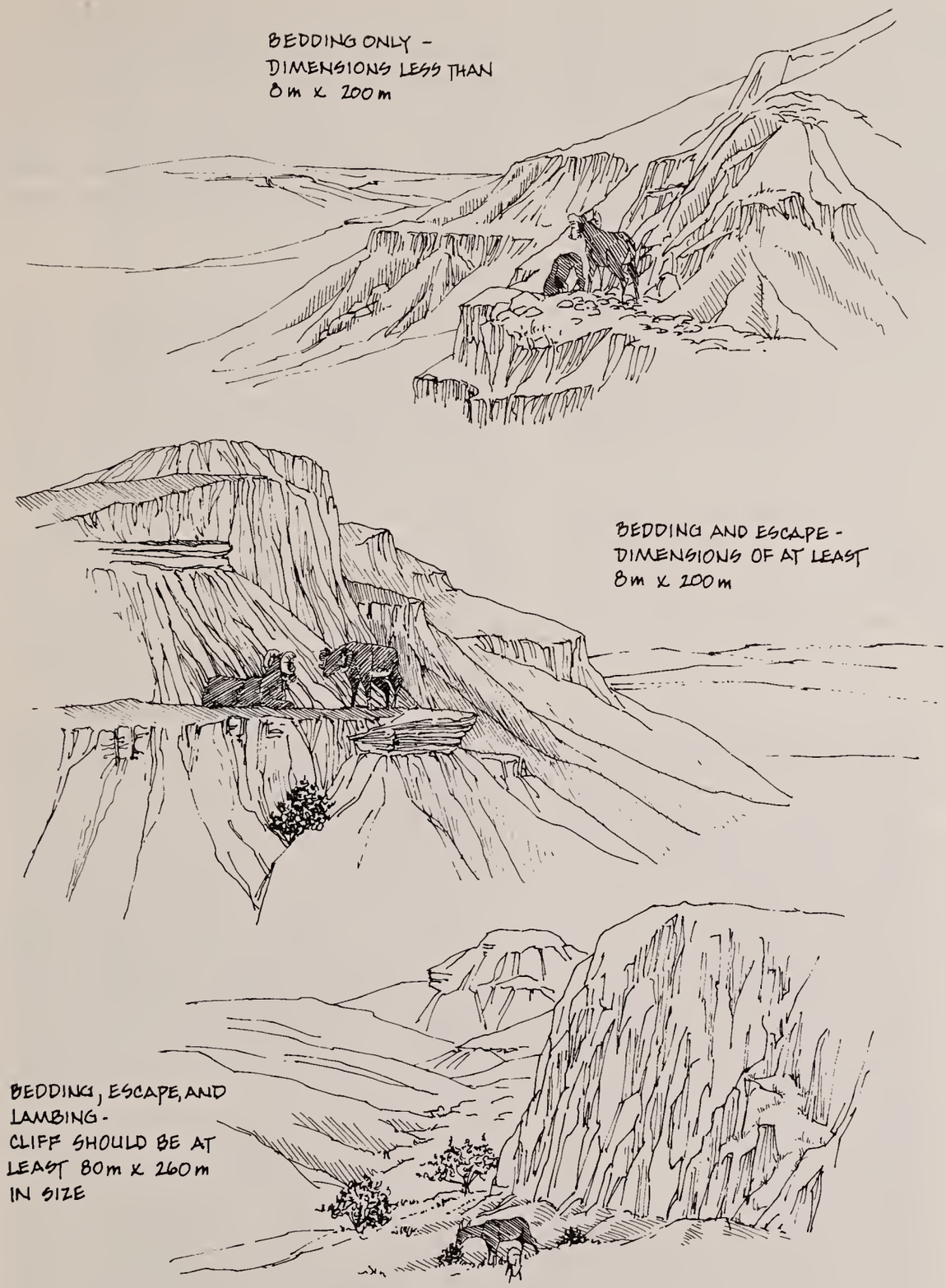

Figure 5.—Size determines the importance of cliffs as habitat for bedding, escape, and lambing.

Cliffs less than 8 meters (26 ft) high by 200 meters (656 ft) long can provide both bedding and thermal areas because they offer some shade in summer and reflect the sun or dissipate absorbed heat in winter. To provide escape terrain cliffs must be at least 8 meters (26 ft) high by 200 meters (656 ft) long or larger (Bailey 1980, McCollough et al. 1980). A series of smaller cliffs with less than 10 meters (33 ft) between them effectively equals a larger cliff. Another way to evaluate cliffs is on the basis of area. Cliffs 0.16 hectare (0.4 acre) and larger can serve as escape terrain as well as bedding and thermal areas, whereas smaller cliffs provide only thermal and bedding areas. To suffice as a lambing area, a cliff or series of cliffs must be at least 2 hectares (5 acres).

Cliffs provide sparse forage and are used for foraging, particularly during lambing season (Van Dyke 1978) and in winter, when forage in adjacent cliffless habitat is unavailable because of crusted snow and ice (Baumann and Stevens 1978, Geist 1971, Geist and Petocz 1977, Shannon et al. 1975). Cliffs do not accumulate as much snow as flatter areas; they reradiate sunrays that melt snow and keep it soft, making it easier for bighorn sheep to paw away snow to obtain forage.

Ewe-lamb groups prefer more rugged topography than ram groups (Blood 1963a, Drewek 1970, Leslie and Douglas 1979) and are more restricted in use of their range (Geist 1971, Leslie and Douglas 1979, Van Dyke 1978). Ram groups will range farther from escape terrain than ewe-lamb groups (Leslie and Douglas 1979). This behavior may be related to their reproductive roles (Geist 1971). Escape terrain may be located above, below, or beside forage and water areas because bighorns can move up or down easily from bedsites to such areas.

The distribution of escape terrain regulates the extent to which other habitat components are used. Most bighorn sheep use forage areas within 0.8 kilometers (0.5 mi) of escape terrain and generally are not seen farther than 1.6 kilometers (1 mi) from escape terrain (Bailey 1980, Denniston 1965, Drewek 1970, Kornet 1978, Leslie and Douglas 1979, McQuivey 1978, Oldemeyer et al. 1971, Van Dyke 1978). Sources of water more than 0.5 kilometer (0.3 mi) from escape terrain receive limited use (Leslie and Douglas 1979). Distances may increase or decrease, depending on the magnitude and frequency of disturbance sheep receive from humans or predators. In general, use decreases as the distance from escape terrain increases. (fig. 6).

LAMBING AREAS

Terrain commonly used for lambing is rugged, precipitous and remote (Drewek 1970, Geist 1971, Irvine 1969, Van Dyke 1978) (fig. 7). Such terrain provides pregnant ewes security and isolation for the lambing period, which includes the time lambs need to become strong enough to follow the ewes. Large cliffs and rock outcroppings with sparse cover of trees or shrubs, such as mountainmahogany, afford both thermal and hiding cover to ewes and lambs (Van Dyke 1978). Ideally, adequate forage and water are found within or near lambing areas so ewes with young lambs do not have to venture far to water or forage (Light et al. 1966, 1967). Ewe-lamb groups stay in lambing areas for about a month after lambing before venturing into adjoining, less rugged habitats (Geist 1971, Van Dyke 1978).

Use of lambing areas is frequently traditional but may be altered by lingering deep snow or insufficient forage or water. Lambing occurs on winter, summer, or spring-fall ranges, depending on prevailing environmental conditions, the location of a pregnant ewe at the critical time, and the nature of the available terrain. The birthplace is usually secluded and in rugged terrain. A ewe may travel several kilometers to such an area to give birth (Geist 1971).

Ruggedness and remoteness influence the size of areas required for lambing. If harassment is great, a larger area is more desirable. Ewes appear to select rugged cliffs of at least 2 hectares (5 acres) with dimensions of at least 80 meters (262 ft) by 260 meters (853 ft). Several ewes may lamb within one such area. Adequate size of an area for lambing depends on outside influences. For example, in remote, extremely rugged topography, where harassment is low, only 1 hectare (2.5 acres) may be sufficient.

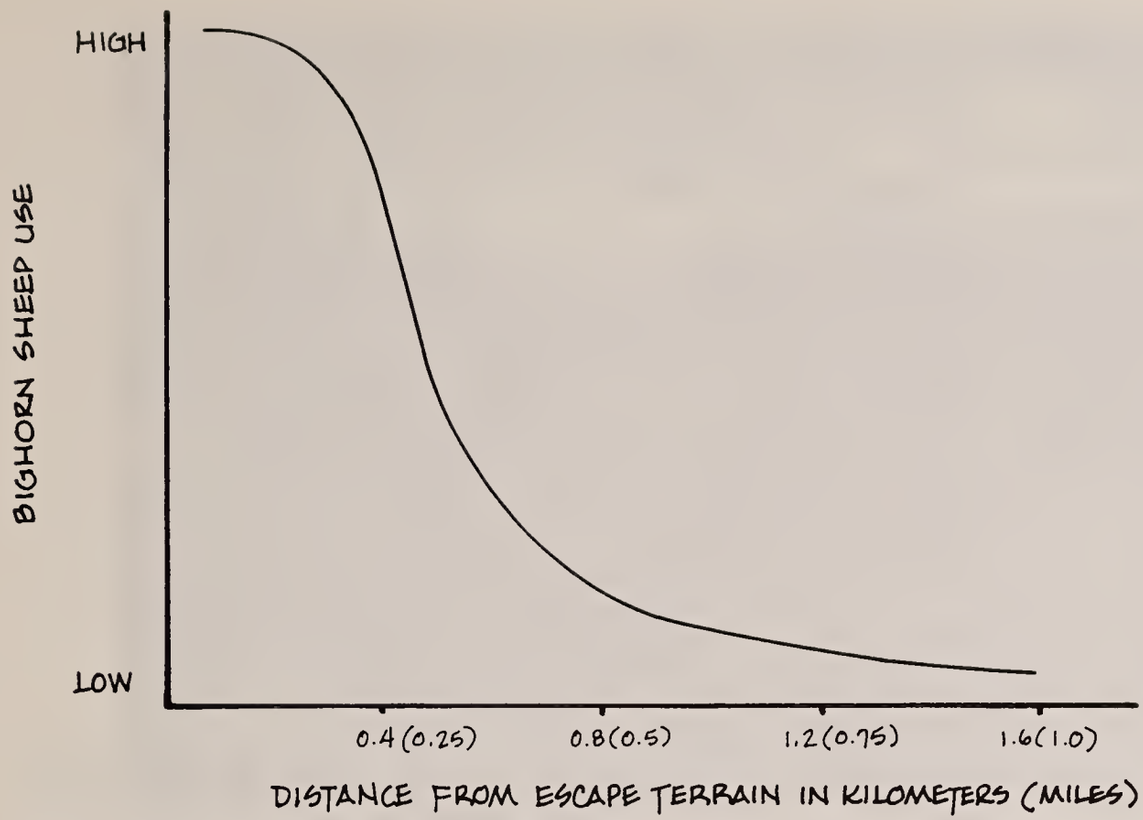

Figure 6.—Distance from escape terrain determines the extent of use.

Figure 7.—Large areas of rugged terrain are preferred for lambing (photo by Walt Van Dyke, courtesy Oregon Cooperative Wildlife Research Unit).

Figure 8.—Plant communities that provide open, low structure are suitable forage areas (photo by Walt Van Dyke, courtesy Oregon Cooperative Wildlife Research Unit).

FORAGE AREAS

Bighorn sheep tend to forage in open areas with low vegetation, such as grasslands, shrublands, or mixes of these (Geist 1971, Hansen 1980, Sugden 1961, Van Dyke 1978) (fig. 8). Perennial bunchgrasses, which make up a large part of bighorn diet (Barrett 1964, Blood 1967, Browning and Monson 1980, Constan 1972, Demarchi 1965, Geist 1971, McQuivey 1978, Pitt and Wikeem 1978, Sugden 1961, Todd 1972) are an important characteristic of these areas.

The importance of grass in a bighorn sheep's diet was substantiated by a study that compared plant consumption in the Great Basin of Nevada to plant availability (Yoakum 1964). On a year-long basis, more grass was consumed (59 percent) than forbs (32 percent), and shrubs (9 percent) (fig. 9). These percentages are noteworthy because a diet primarily of grass was selected from a cold desert where shrubs predominated. Similar findings were reported by Barrett (1964) in Nevada.

A variety of plant species, common to southeastern Oregon, provide important forage for bighorn sheep (table 1). Lists of plant species can be used to predict the importance of areas for forage, but amounts consumed by bighorn sheep will vary with species composition, range condition, and plant productivity.

Although grass is a staple of the bighorn sheep's diet, a variety of browse and forbs are also used seasonally in varying amounts (Johnson and Smith 1980, Todd 1972). On some ranges where grass or forbs are sparse, diets may consist primarily of browse (Howard and Lorenzo 1975). For the most part, bighorn sheep seem to be opportunistic foragers and, if the physical structure of the habitat is appropriate, can adapt their diet to available plant communities—whether they are dominated by grass, forbs, or shrubs (Browning and Monson 1980, Robinson and Cronemiller 1954).

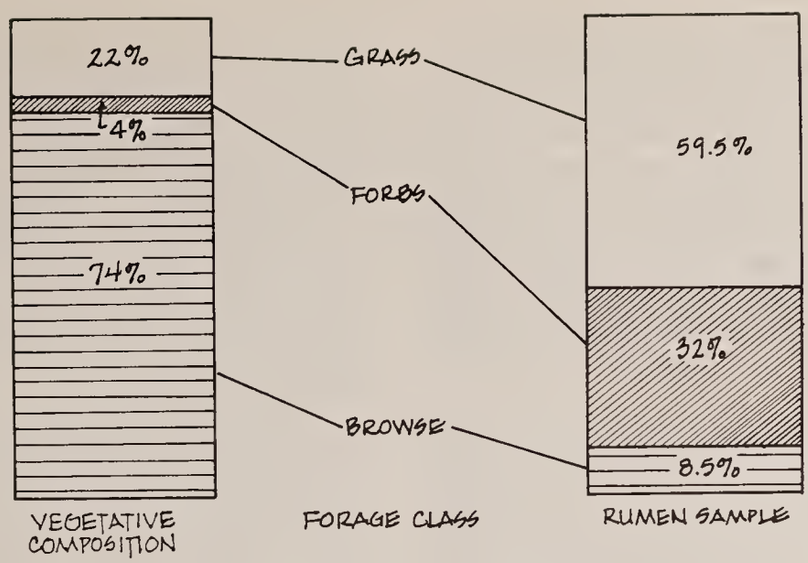

Figure 9.—Comparison of vegetative composition and percent volume of forage classes represented in 12 rumen samples from bighorn sheep on the Silver Peak range, Nevada. (Redrawn from Yoakum 1964)

Table 1—Plants common to the Great Basin of southeastern Oregon and their seasonal occurrence in the diet of bighorn sheep[1]

Plant species by forage class	Level of use[2]			
	Winter	Spring	Summer	Fall
Grasses:				
Bearded bluebunch wheatgrass	H	H	M	M
Idaho fescue	M	M	L	M
Bluegrass	L	H	M	M
Bottlebrush squirreltail	L	L	—	L
Prairie junegrass	L	M	L	L
Pinegrass	L	L	L	M
Indian ricegrass	M	M	—	M
Giant wildrye	M	M	M	L
Cheat grass	L	M	—	—
Sedge	L	M	M	L
Thurber's needlegrass	M	M	L	M
Meadow barley	M	—	—	—
Forbs:				
Arrowleaf balsamroot	L	M	L	—
Phlox	—	—	L	L
Milkvetch	L	L	L	—
Lupine	L	L	L	L
Cushion buckwheat	—	M	M	—
Buckwheat	L	L	L	L
Penstemon	L	—	L	—
Lomatium	M	M	—	—
Erigeron	—	M	M	—

Table 1—Continued

Plant species by forage class	Level of use[2]			
	Winter	Spring	Summer	Fall
Cobre rockcress	—	M	M	—
Western tansymustard	—	L	—	—
Daggerpod	—	—	M	—
Yarrow	L	L	L	L
Trees and shrubs:				
Big sagebrush	M	L	L	—
Low sagebrush	M	—	M	M
Bud sagebrush	M	L	—	—
Winterfat	M	M	M	H
Rabbitbrush	L	L	L	L
Fourwing saltbush	M	L	L	M
Bitterbrush	H	H	M	—
Mountainmahogany	H	M	L	M
Service berry	L	L	M	L
Elderberry	—	—	L	L
Chokecherry	L	L	L	L
Spiraea	L	L	M	L
Wild rose	L	L	M	L
Ninebark	M	M	M	L
Currant	L	—	—	L
Cinquefoil	—	—	—	M
Willow	L	L	M	M
Snowberry	L	L	M	L
Oceanspray	—	L	L	L
Spiny hopsage	—	—	—	M

[1] Adapted from Blood (1967), Cooperrider et al. (1980), Drewek (1970), Dunaway (1972), Estes (1979), Fairaizl (1978), Hansen (1982), Kornet (1978), Lauer and Peek (1976), McCullough and Schneegas (1966), Pitt and Wikeem (1978), Sugden (1961), Todd (1972), Van Dyke (1978), Yoakum (1966).

[2] L = light, 1 to 5 percent; M = moderate, 6 to 20 percent; H = heavy, 21 to 50+ percent; — = no data available.

Production of forage depends on the amount and timing of precipitation. Managers can estimate the amount of forage available for bighorn sheep only after deducting for plant needs and the amount to be used by other grazing animals.

Forage intake of bighorn sheep is determined by their energy requirements and the availability and quality of forage (Hebert 1973). The amount needed varies with protein content, ambient air temperature, and the sex, age, and activity level of the animal. Apparently consumption does not vary markedly from year to year. Few studies have been conducted to determine the amount of forage required by bighorn sheep, but estimates have been made by Anderson and Denton (1978), Hansen (1980), and Hebert (1973). Such estimates should be used only as a guide in southeastern Oregon and should be updated as more data become available.

Hansen (1980) found that desert bighorn sheep consumed from 1.5 to 1.8 kilograms (3 to 4 lbs) of dry alfalfa per day. Anderson and Denton (1978) in Idaho, and Hebert (1973) in British Columbia, figured the year-round average intake for Rocky Mountain bighorn sheep was 1.44 kilograms per 45.40 kilograms of body weight (3.17 lbs per 100 lbs). A bighorn sheep with an average weight of 56.4 kilograms (124 lbs) would consume 1.77 kilograms (3.90 lbs) of dry matter each day. Once the percentages of grasses, forbs, and shrubs in the diet of sheep are known and the percentages of each that can be provided by the plant communities are known, a more accurate computation of forage available can be made.

Because they depend largely on their acute vision to detect danger, bighorn sheep shun areas of dense, tall vegetation, such as riparian zones and forests (Geist 1971, Kornet 1978, McCann 1956, Oldemeyer et al. 1971, Risenhoover and Bailey 1980, Turner and Weaver 1980) (fig. 10). They avoid extensive forage areas with shrub or canopy cover in excess of 25 percent and shrubs about 60 centimeters (2 ft) high on mild slopes (Van Dyke 1978), whereas, on steep slopes they have been noted to travel through and bed in dense brush (Light et al. 1967).

The availability of water and escape terrain also affects use of forage areas. The more abundant and evenly dispersed these components are, the more uniform use of a forage area will be. Forage areas located farther than 0.8 kilometers (0.5 mi) from escape terrain and farther than 1.6 kilometers (1 mi) from water are little used (Bailey 1980, Blong and Pollard 1968, Denniston 1965, Irvine 1969, Kornet 1978, Leslie and Douglas 1979, McQuivey 1978, Oldemeyer et al. 1971, Van Dyke 1978).

Snow accumulation seems to be the principal factor that triggers bighorn sheep to move from summer to winter ranges (Geist 1971, Geist and Petocz 1977). Where winter and year-long ranges accumulate snow, animals seek areas of least snow depth and paw away snow to uncover forage (Drewek 1970, Geist 1971, Geist and Petocz 1977, Shannon et al. 1975). In Idaho, Lauer and Peek (1976) found that from November through May, 87 percent of bighorn sheep sightings were in areas with less than 5 centimeters (2 inches) of snow, and 97 percent were in areas with less than 16 centimeters (6 inches).

Bighorn sheep prefer green forage and will move up or down or to different aspects to acquire more palatable forage (Hebert 1973, Lauer and Peek 1976, McCann 1956, Shannon et al. 1975, Van Dyke 1978).

Forage areas that present a variety of aspects are preferable because they provide green forage for longer periods. For example, south aspects are generally warmer and provide green forage earlier in spring, while north aspects are generally cooler and provide green forage later in summer. Because they are warmer, south aspects generally have less snow during winter and are selected by bighorn sheep (Bailey 1980, Drewek 1970, Lauer and Peek 1976, Light et al. 1967, McCollough et al. 1980, Van Dyke 1978).

Suitable versus Unsuitable Forage Areas

It is difficult to classify forage areas as suitable or unsuitable solely on the basis of plant species composition. Topography, substrate, vegetative structure, distance to escape terrain

Figure 10.—Bighorn sheep prefer open areas and shun tall dense stands of trees or shrubs (photo by Walt Van Dyke, courtesy Oregon Cooperative Wildlife Research Unit).

and water, snow depth, and season are also important. Forage areas suitable for bighorn sheep usually have tree or shrub canopy cover of less than 25 percent and shrub height less than 0.6 meters (2 ft). They are less than 1.6 kilometers (1 mi) from water and less than 0.8 kilometers (0.5 mi) from escape terrain. If the above criteria are met, any of the plant communities of southeastern Oregon can provide some forage.

We have rated the major plant communities (in the order listed by Dealy et al. (1981)) according to their suitability as forage for bighorn sheep. On a scale of 1 (low) to 10 (high), ratings are:

Plant Community	Rating
Riparian	5
Quaking aspen/grass	2
Quaking aspen/mountain big sagebrush	2
Curlleaf mountainmahogany/mountain big sagebrush/bunchgrass	5
Curlleaf mountainmahogany/mountain snowberry/grass	4
Curlleaf mountainmahogany/Idaho fescue	4
Curlleaf mountainmahogany/bearded bluebunch wheatgrass-Idaho fescue	4
Curlleaf mountainmahogany/pinegrass	3
Western juniper/big sagebrush/bearded bluebunch wheatgrass	6
Western juniper/big sagebrush/Idaho fescue	6
Basin big sagebrush/bunchgrass	7
Mountain big sagebrush/bunchgrass	9
Subalpine big sagebrush/bunchgrass	9
Wyoming big sagebrush/bunchgrass	8
Three-tip sagebrush/bunchgrass	1
Bolander silver sagebrush/bunchgrass	1
Mountain silver sagebrush/bunchgrass	1
Stiff sagebrush/bunchgrass	7
Low sagebrush/bunchgrass	7
Cleftleaf sagebrush/bunchgrass	1
Black sagebrush/bunchgrass	7
Early low sagebrush/bunchgrass	7
Squaw apple/bunchgrass	2
Black greasewood/bunchgrass	1
Shadscale saltbush/bunchgrass	3
Meadow, seasonally wet	10
Meadow, permanently wet	8
Subalpine bunchgrass	10

Several plant communities in the Great Basin seldom provide forage because of their structure or distance from escape terrain. Communities unsuitable because of structure are: quaking aspen, mountainmahogany, western juniper, and riparian communities dominated by tall shrubs or trees. Communities usually located far from escape terrain and little used for foraging include: squaw apple/bunchgrass, black greasewood/grass, early low sagebrush/bunchgrass, black sagebrush/bunchgrass, Bolander silver sagebrush/bunchgrass, mountain silver sagebrush/bunchgrass, threetip sagebrush/bunchgrass, shadscale saltbush/bunchgrass, and cleftleaf sagebrush/bunchgrass. These communities will get incidental use along migration routes or within established herd ranges.

Successional communities that result from wildfire or seedings, such as crested wheatgrass, are also encountered in the Great Basin and may provide forage if the location and successional/seral structure are appropriate.

Summer versus Winter Range

The variation in elevation and topography in the Great Basin creates microsites that differ in accumulations of snow. Some areas may be available for foraging only during a 3-month summer period before snow depth precludes use. In such cases, bighorn sheep may establish patterns of seasonal use of such areas.

Other areas suitable for foraging may accumulate little or no snow and receive year-long use. Areas that provide suitable forage year-round are particularly vulnerable to overuse because of competition among a variety of wild or domestic herbivores.

WATER

Bighorn sheep use fresh water from many sources. These include dew, streams, lakes, springs, ponds, catchment tanks, troughs, guzzlers, and developed seeps or springs (Blong and Pollard 1968, Drewek 1970, Halloran and Deming 1958, Jones et al. 1957, Sugden 1961, Turner and Weaver 1980, Van Dyke 1978, Welles and Welles 1961, Yoakum et al. 1980). Alkaline waters, however, apparently are not suitable (Jones et al. 1957). Although the degree of alkalinity tolerated by bighorn sheep is unknown, the maximum dissolved solids suitable for ungulate wildlife has been described as 4,500 p/m (McKee and Wolf 1963). We assume that this figure also applies to bighorn sheep.

The amount of water needed by a bighorn sheep depends on several factors, including: size of the animal, activities, time between waterings, physiological adaptation, environmental stress (humidity and temperature), succulence of ingested forage, and reproductive status (Turner and Weaver 1980). A bighorn sheep ingesting succulent forage on a cool day requires little or no free water, whereas one ingesting dry forage on a hot day needs more free water (Turner and Weaver 1980). There is a greater need for water during periods of physiological stress, such as during rutting or lambing seasons (Wilson 1968).

Desert bighorn sheep have been known to go without water for more than 5 days during summer (Turner and Weaver 1980). They may drink as little water per day as 4 percent of their body weight and as much as 23 percent of their body weight at one time (Turner 1973, Turner and Weaver 1980). Koplin (1960) found that a captive herd of desert bighorn sheep that were fed a dry ration and provided unlimited water drank an average of 4.9 liters (1.3 gal) per day, while free-ranging bighorns were observed to drink as much as 9.5 liters (2.5 gal) per day during summer. Frequency of watering and succulence of vegetation both influence water consumption. A reasonable estimate of the minimum amount of water needed by free-ranging, adult California bighorn sheep of average size (56.4 kilograms, 124 lbs), is 3.5 liters (1.5 gal) per day.

Bighorn sheep spend most of their time within 1.6 kilometers (1 mi) of free water but have been located as far as 3.2 kilometers (2 mi) from it (Blong and Pollard 1968, Irvine 1969, Leslie and Douglas 1979). Water sources more than 0.5 kilometer (0.3 mi) from escape terrain or surrounded by tall dense vegetation are shunned by bighorn sheep (Hansen 1980, Leslie and Douglas 1979, Turner and Weaver 1980).

As the number of water sources declines, habitat use becomes more confined around remaining water sources (Jones et al. 1957, Leslie and Douglas 1979, Welles and Welles 1961). But as precipitation, new plant growth, and cooler temperatures reduce dependence on permanent water, the animals can temporarily extend their range (Leslie and Douglas 1979).

THERMAL PROTECTION

Elevation, thermal winds, cliffs and rock outcroppings, and trees and shrubs, provide animals the opportunity to minimize stress caused by temperature extremes (fig. 11). Some bighorn sheep herds move to higher elevations in summer because of available forage and a cooler environment (McCann 1956, Shannon et al. 1975). On subalpine summer ranges where winds were consistent bighorn sheep used little shade.[2] Where summer ranges are below the subalpine zone, bighorn sheep seek shade from geomorphic features to moderate the effects of high temperatures (Leslie and Douglas 1979, Welles and Welles 1961). The amount of energy bighorn sheep expend in thermoregulation will be reduced if the geomorphic features offer a variety of aspects, thus increasing the amount of shade available at different times of day.

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[2] Van Dyke, Walter A., wildlife biologist. 1978 data on file at Oregon Department of Fish and Wildlife, Enterprise, Oregon 97828.

Figure 11.—Cliffs, trees, and shrubs provide shade.

Shrubs and trees with dense canopies provide varying degrees of thermal cover for deer and elk (Thomas et al. 1976). Bighorn sheep normally occupy open areas and consequently do not benefit from the thermal protection offered by tall, dense-canopied vegetation, but they do use trees and shrubs to some extent for this purpose (Hansen 1980, Smith 1954). Mountainmahogany stands, with 25-percent canopy cover, located on cliffs or ground steeper than 35 percent, are apparently used for protection from the sun, especially by ewes during lambing season (Van Dyke 1978). Habitats with dense canopy cover on gentle slopes (less than 35 percent) are used less or even avoided, probably because sheep have poor visibility from within such stands (Van Dyke 1978). In general, use of trees and shrubs for thermal cover is positively correlated with slope and roughness of terrain and negatively correlated with increasing canopy cover, density, and distance from escape terrain.

Cliffs and rock outcroppings provide shade on hot days and reflect solar radiation during cold periods. Bighorn sheep seek shade during midday and thus conserve body water (Leslie and Douglas 1979) and enhance metabolic efficiency (Moen 1973). Caves are sometimes used for this purpose (Hansen 1980, Leslie and Douglas 1979, Welles and Welles 1961) as well as for lambing (Fairaizl 1978, Hansen 1980) and for shelter during severe storms (Smith 1954) (fig. 12).

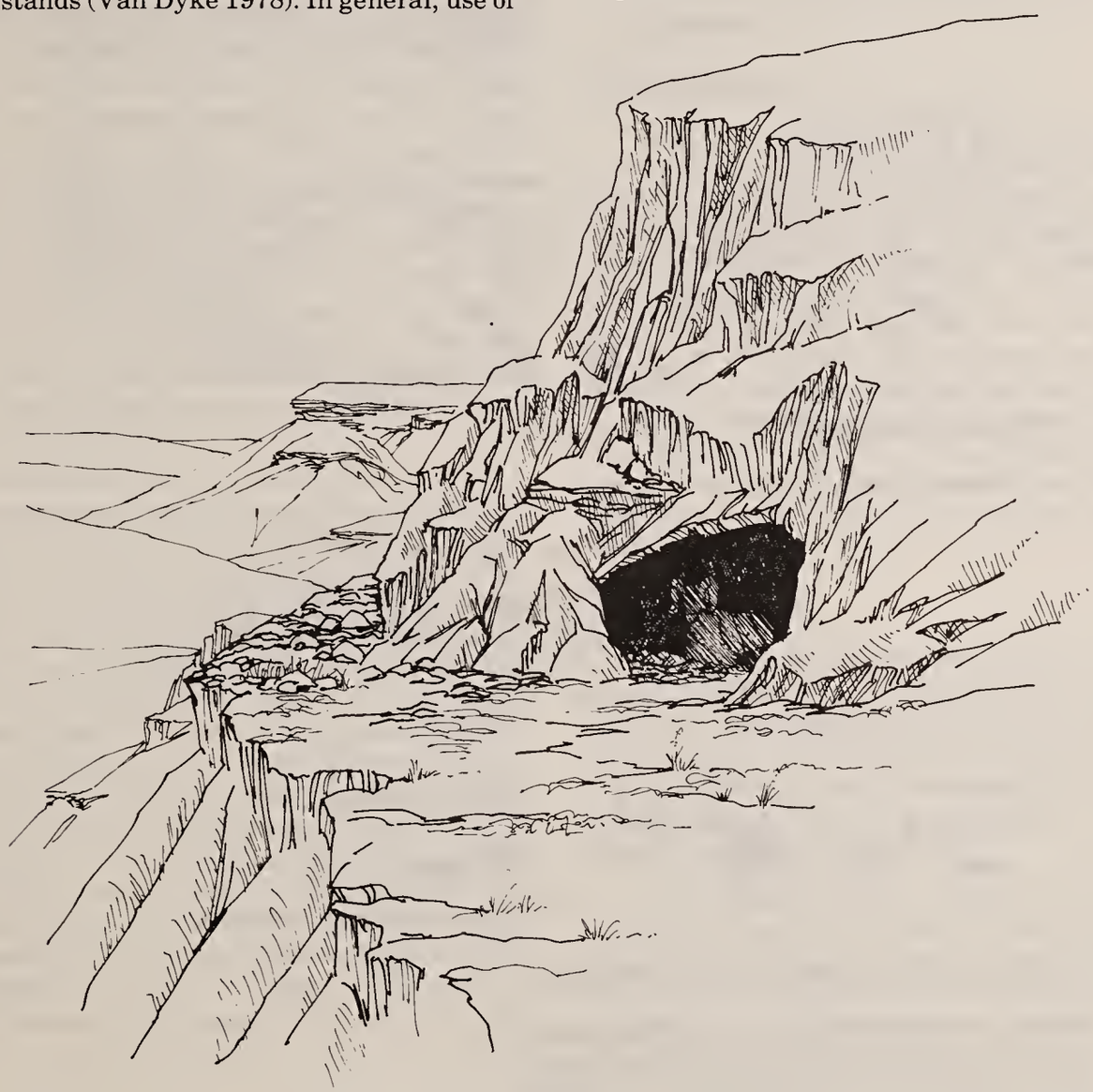

Figure 12.—Caves provide thermal cover and lambing sites.

RUTTING AREAS

A bighorn sheep herd usually has discrete areas within its range where breeding occurs. A herd may move to traditional rutting areas (Demarchi and Mitchell 1973, Geist 1971) or rams may move to ewe-lamb ranges (Kornet 1978, Van Dyke 1978) for the rut.

During the rut, which occurs from late October to mid-December, the need for forage and water changes. For example, bighorn sheep forage less when rutting (Geist and Petocz 1977) but require more water than usual (Wilson 1968).

ARRANGEMENT OF HABITAT COMPONENTS

Forage, water, and escape terrain are the most important components of bighorn sheep habitat, but the size, quality, and distribution of these components are also important. In the best habitats, water sources and escape terrain are distributed throughout foraging areas and thus make more grazing available. This intermingling of habitat components reduces pressure on forage near water and escape routes and helps prevent degradation of plant communities.

Forage areas within 0.8 kilometer (0.5 mi) of escape terrain on two or more sides receive more frequent and uniform use than forage areas with escape terrain on only one side (fig. 13).

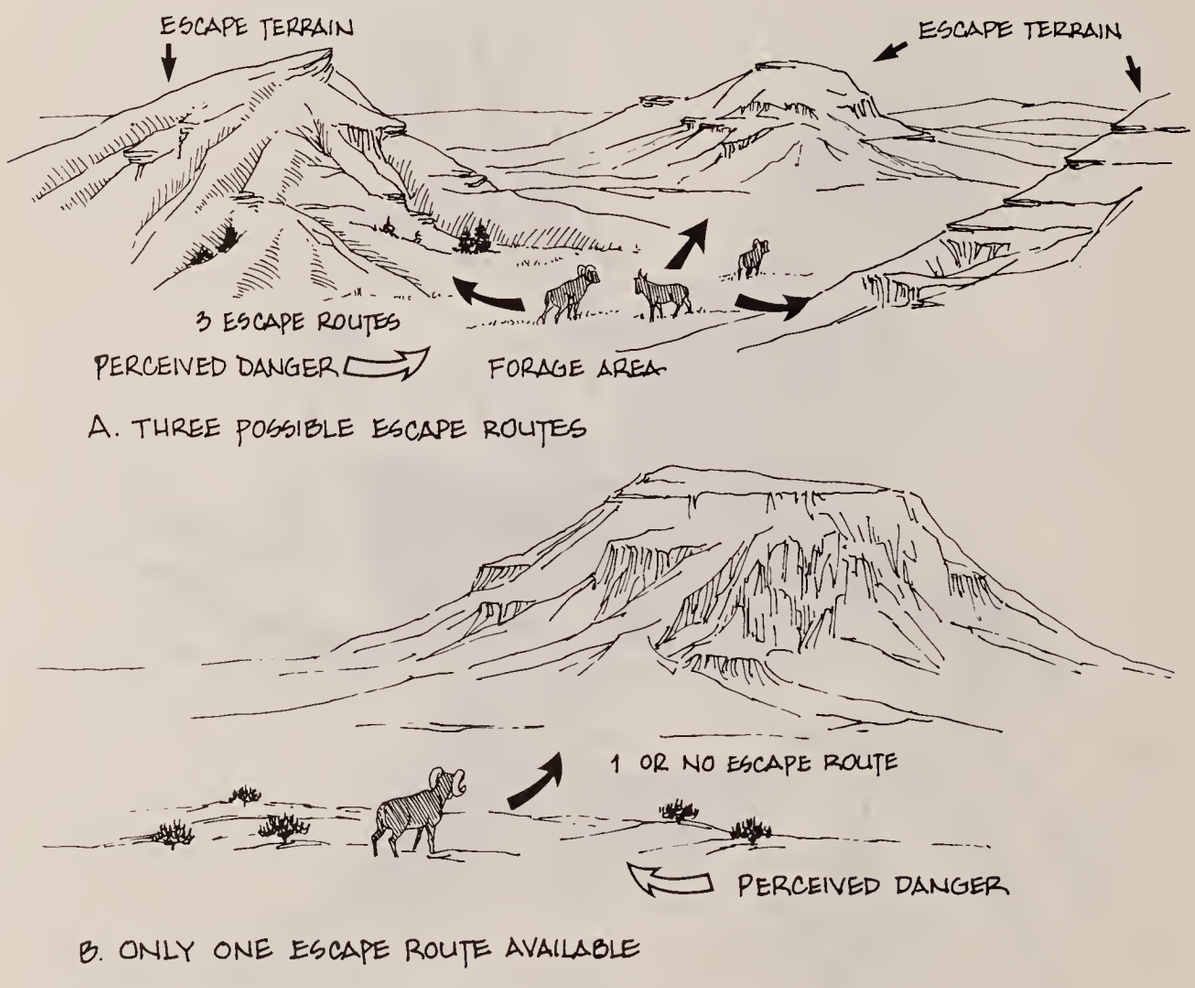

Figure 13.—Uniform distribution of sufficient escape terrain is important to bighorn sheep. In A three different escape routes are available; in B only one; consequently, sheep will forage closer to escape terrain in B than in A.

The location of water also influences use of forage areas. If water is distributed at intervals of 3.2 kilometers (2 mi) or less throughout a range and is not farther than 0.5 kilometer (0.3 mi) from escape terrain, optimum use of the habitat can be expected. Sheep will then forage in a circuit, covering more area and putting less grazing pressure on desirable portions of the area.

SPACE REQUIREMENTS

Bighorn sheep require more than the essential components of appropriately arranged habitat. They also need space. Hansen (1980:74) described space as ". . . a lack of crowding." The amuont of space needed depends on quality of habitat, the amount of negative impact from humans and other animals, and the size of the bighorn herd. Trefethan (1975) suggested that a minimum herd size of 125 animals is necessary for a long-term, viable population. The area required by such a herd depends on the quality of the habitat. Kornet (1978) and Van Dyke (1978) have calculated minimum densities of 1.9 bighorns per square kilometer (5/sq mi) for herds in the Great Basin of southeastern Oregon. These figures can be used as a guide for estimating the population potential of a given habitat but may exceed the capacity of poorer quality habitat.

Individuals of every bighorn sheep population apparently vary in their tolerance of crowding. For example, individual Rocky Mountain bighorn sheep accustomed to people in a National Park can be photographed from a car window, but individuals unaccustomed to people may flee at the sight of a person or vehicle a mile or more away. Once the limit of tolerance is exceeded, even in otherwise optimum habitat, sheep may abandon an area temporarily or permanently (Light 1971, Spalding and Bone 1969, Wehausen 1980, Welles and Welles 1961). Although bighorn sheep are naturally gregarious, crowding can be detrimental. Crowding may result from a lack of suitable habitat, snow accumulation, structural condition of plant communities, presence of other ungulates, or harassment by humans or predators. The amount of space needed by bighorn sheep varies with habitat conditions and size of the population. Adverse effects on a sheep population are indicated by abandonment of an area, a drop in productivity, or excessive mortality.

Productivity and survival are enhanced by appropriate interspersion of adequate water, forage areas, and escape terrain, as well as sufficient space, to allow bighorn sheep to use habitat efficiently and minimize energy expenditures and exposure to disturbance.

Management Tips

The attributes of bighorn sheep habitat can be created, preserved, destroyed, or altered by management action.

ESCAPE AREAS

Escape terrain is provided naturally by the environment. Without it bighorn sheep will not flourish (Hansen 1980). Rarely can it be enhanced, but it can be altered detrimentally by such activities as mining and constructing roads and reservoirs (fig. 14). In many cases, physical alterations are much less important than the disturbance these alterations introduce. For example, human use of a road along or through a lambing or bedding area eliminates the solitude needed by sheep. Likewise, development of a large reservoir may allow human access by boat to areas formerly remote and inaccessible.

LAMBING AREAS

The relatively isolated and rugged cliffs cannot be created, but other attributes of prime lambing habitat can be enhanced. Size of lambing areas can be increased by manipulation of adjacent forage areas, development of water sources, and control of competing animal species and people.

The availability of forage and water within and bordering lambing areas is critical. More water can be made available by development or conservation. Forage can be conserved and made available to ewes and young lambs.

Figure 14.—Reservoirs may submerge habitat suitable for bighorn sheep (photo by Walt Van Dyke, courtesy Oregon Cooperative Wildlife Research Unit).

Bighorn sheep will tolerate some human intrusion most of the year, but the lambing period is critical, and the less disturbance the better.

If a herd has traditional areas for lambing (Geist 1971), management should insure that travel corridors to such areas are protected and maintained.

FORAGE AREAS

Plant communities vary widely. Differences in species composition and structural features are largely the result of past fire and grazing. Fire tends to reduce the abundance of shrubs and trees, while grasses and forbs are affected less or even increased (Franklin and Dyrness 1973, Graf 1980). Prolonged, heavy grazing by livestock has the opposite effect (McQuivey 1978); grazing pressure is directed to palatable plants, and unpalatable plants tend to dominate over time (Stoddart et al. 1975).

Dense shrub and tree canopy or undesirable woody plants can be reduced temporarily or eliminated by prescribed fire. Bighorn sheep select forage areas that have been burned (Geist 1971, Graf 1980, Peek et al. 1979, Riggs 1977, Shannon et al. 1975, Stelfox 1971) (fig. 15). Burning may improve plant production and palatability (Peek et al. 1979). Logging, chaining, or spraying should give similar results, but not as quickly, and debris may present a problem (Morgan 1969, Spalding and Bone 1969, Sugden 1961). The goal of any treatment to enhance forage areas is to create the more open habitat preferred by bighorn sheep. The extent to which mechanical methods of vegetative manipulation can be implemented depends on geomorphic features and topography.

Figure 15.—Fire has removed tree canopy and created a suitable forage area (photo by Walt Van Dyke, courtesy Oregon Department of Fish and Wildlife).

Conflict between bighorns and other grazing species in forage areas appears in two primary forms—social interaction and direct competition. Detrimental social interactions have been documented between bighorn sheep and cattle (Dean 1977, Irvine 1969, Russo 1956, Wilson 1968) and goats (Russo 1956, Wilson 1968). When cattle or goats occupy ranges used by bighorn sheep, the sheep move to less desirable areas or concentrate on the remaining habitat. If bighorn sheep are to be featured, socially conflicting species may have to be removed. Fortunately, the nature of bighorn sheep and the severe topography they inhabit usually results in their isolation from domestic livestock. Adverse social interactions between bighorn sheep and mule deer, elk, or pronghorns have not been reported in the literature.

Whenever two or more species of grazing animals are found in the same area, competition for forage is possible, but inherent characteristics usually allow species to partition a particular resource. Competition between two species may be caused by inclement weather, the introduction of exotic ungulates, or the improper management of animal numbers—domestic or wild (Crump 1971, Sugden 1961, Weaver 1972). There are documented accounts of competition for forage between bighorn sheep and cattle (Blood 1961, Demarchi 1965, Demarchi and Mitchell 1973, Lauer and Peek 1976, Morgan 1968, Stelfox 1971); horses (Crump 1971; McQuivey 1978; Schallenberger 1965; Stelfox 1971, 1976; Woodgerd 1964); elk (Buechner 1969, Cowan 1947, Schallenberger 1965, Stelfox 1971); deer (Berwick 1968, Buechner 1960, Cooperrider 1969, Drewek 1970, Morgan 1968, Schallenberger 1965, Stelfox 1971); and domestic sheep (Morgan 1968, Uhazy et al. 1971). Most of the competition was on bighorn winter ranges. In the case of domestic livestock, competition for forage resulted from livestock grazing on bighorn winter ranges during summer.

The result of competition was generally twofold—inadequate forage for one or more species and severe impairment of range quality. Forage allocation and grazing management to accommodate bighorn sheep and other grazers has been achieved by reducing the number of domestic or wild ungulates and/or controlling the intensity of domestic livestock grazing and season of use (Crump 1957, 1971; Stelfox 1971). Similar solutions can be implemented on other seasonal ranges. Livestock grazing on bighorn range has been completely stopped in some areas (Lange et al. 1980).

Competition for forage is more pronounced where livestock grazing occurs on ranges of nonmigratory bighorn sheep. Because of social conflicts and the forage needs of bighorn sheep, it is preferable that domestic livestock not be grazed within the year-long home ranges of bighorn sheep. If grazing by livestock must occur, it should be confined to only a portion of the bighorn range and periodically moved in a planned grazing system (Anderson 1967). Such action will minimize competition between domestic livestock and bighorn sheep (Anderson and Scherzinger 1975).

The best way to assure an adequate food source for bighorn sheep may be to reserve forage areas adjacent to their escape terrain, lambing areas, and water sources. Allowing domestic livestock in such areas risks depletion of the food supply, which may be limited (Crump 1957, 1971; Stelfox 1971). Food supplies may also be limited by the bighorn sheep's inability or unwillingness to readily change home ranges (Geist 1971).

If domestic livestock are grazed on bighorn sheep range, their use should alternate with sheep use. Livestock grazing must be done with utmost care to insure: adequate forage supplies for the sheep at the appropriate season, protection of the range vegetation and soils, and minimum harassment of the sheep. These objectives may be attained by fencing, limiting numbers of livestock, grazing on rotational or seasonal systems, placing salt and water to attract livestock away from bighorn forage, and using fertilizers to improve palatability of forage for livestock (Bear 1978, Bodie and Hickey 1980, Martin 1978, McCollough et al. 1980, Meehan and Platts 1978, Skovlin 1965, Stoddart et al. 1975). If the management priority is the welfare of bighorn sheep, other wild or feral ungulates (primarily deer, elk, and horses) may have to be reduced by killing or capture and removal to maintain sufficient forage for bighorn sheep and minimize adverse social interactions.

Managers will often be faced with problems caused by the effects of fences on bighorn sheep. Fences restrict movement and cause mortality, especially of rams that get their horns tangled in the wire (Welsh 1971). Helvie (1971) has given guidelines for building fences in areas occupied by bighorn sheep. Fences should not be constructed with woven wire, but with smooth or barbed wire, pipe, rails, or poles. Helvie also recommended that posts or stays be placed no farther apart than 3 meters (10 ft). Wires should be spaced 51, 89, and 99 centimeters (20, 35, and 39 inches) above the ground, and poles, pipes or rails 51, 97, and 112 centimeters (20, 38, and 44 inches) above the ground (fig. 16). Such spacing allows bighorns to go through or under a fence while restricting livestock movement.

Another type of fence that can be used is the lay-down fence (fig. 16). It can be erected when cattle are present and dropped flat when bighorn sheep are present.

Use of fences should allow bighorn sheep to move through an area while keeping cattle on designated pastures.

In selecting objectives for managing a range for bighorn sheep, a manager should answer three questions: (1) What are the requirements of the particular bighorn sheep population? (2) Do other wild, feral, or domestic ungulates occupy the area with the sheep? and (3) Do these occupants alter the habitat in ways that are detrimental to the sheep? Bighorn sheep are a much more sensitive part of the management equation than mule deer, elk, feral horses, or domestic livestock. Bighorn sheep are comparatively rare. They occupy habitats that are sensitive to alteration, and they respond adversely to disturbance. Unless they are given primary emphasis, bighorn sheep are unlikely to become established or to continue in existence.

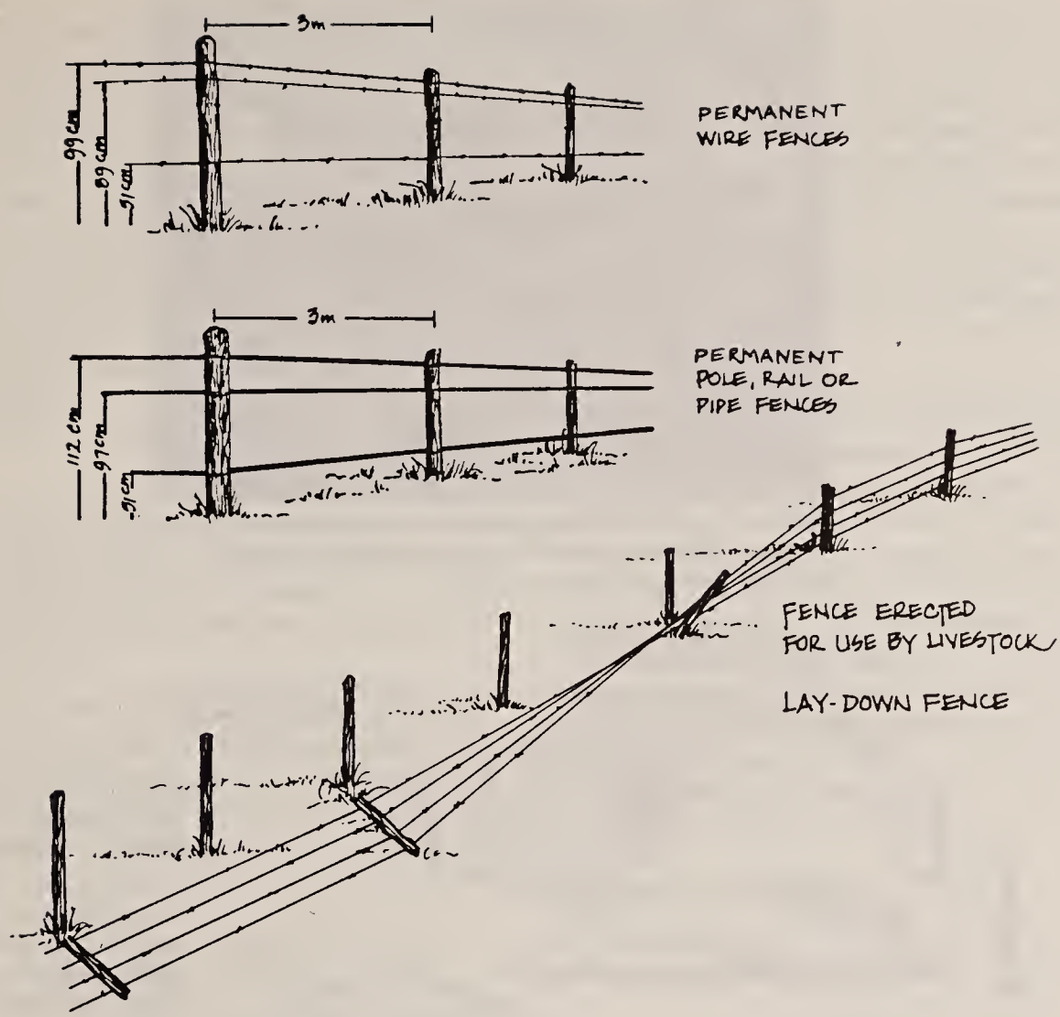

Figure 16.—Types and dimensions of fences that can be used on bighorn sheep range.

Bighorn sheep ranges, present and potential, occupy such a small percentage of area suitable for grazing domestic livestock, that reserving forage for bighorn sheep will have little overall impact on domestic livestock (fig. 17).

WATER

If water is absent or limited on otherwise suitable bighorn sheep range, steps can be taken to conserve existing water and to make new sources available under circumstances that encourage bighorn sheep use.

If water is not available from permanent, natural sources, impoundments can be developed to provide it. Water from seeps, low-flow springs, seasonal springs, and seasonal streams can be collected, stored, and conserved to make it available during critical periods of the year (Halloran and Deming 1958, Jones et al. 1957, Wilson 1977, Yoakum et al. 1980).

If water from runoff, springs, or seeps is absent, guzzlers with large collection aprons (Yoakum et al. 1980) can be used to collect it (fig. 18). Water sources that are constructed to collect runoff or seepage water will be most beneficial in ravines or crevices where such water is likely to be available. It may be desirable to pipe water from a development to troughs—to prevent mucking—or to locations better suited for use by bighorn sheep.

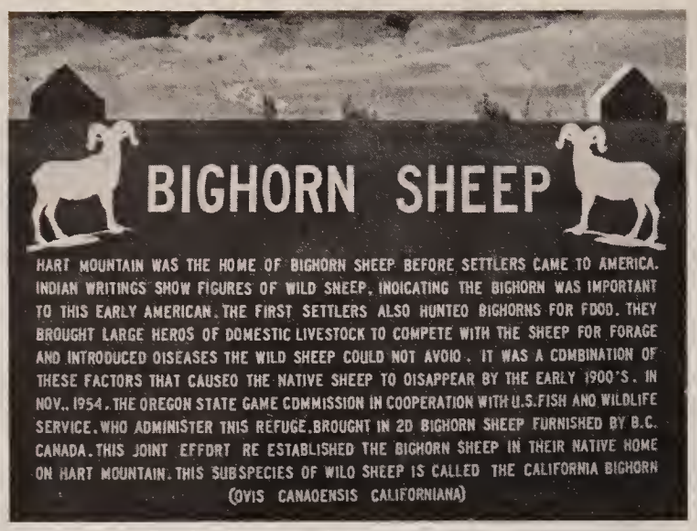

Figure 17.—In the future, bighorn sheep may depend on parcels of land set aside and managed primarily for them (photo by Alan Sands).

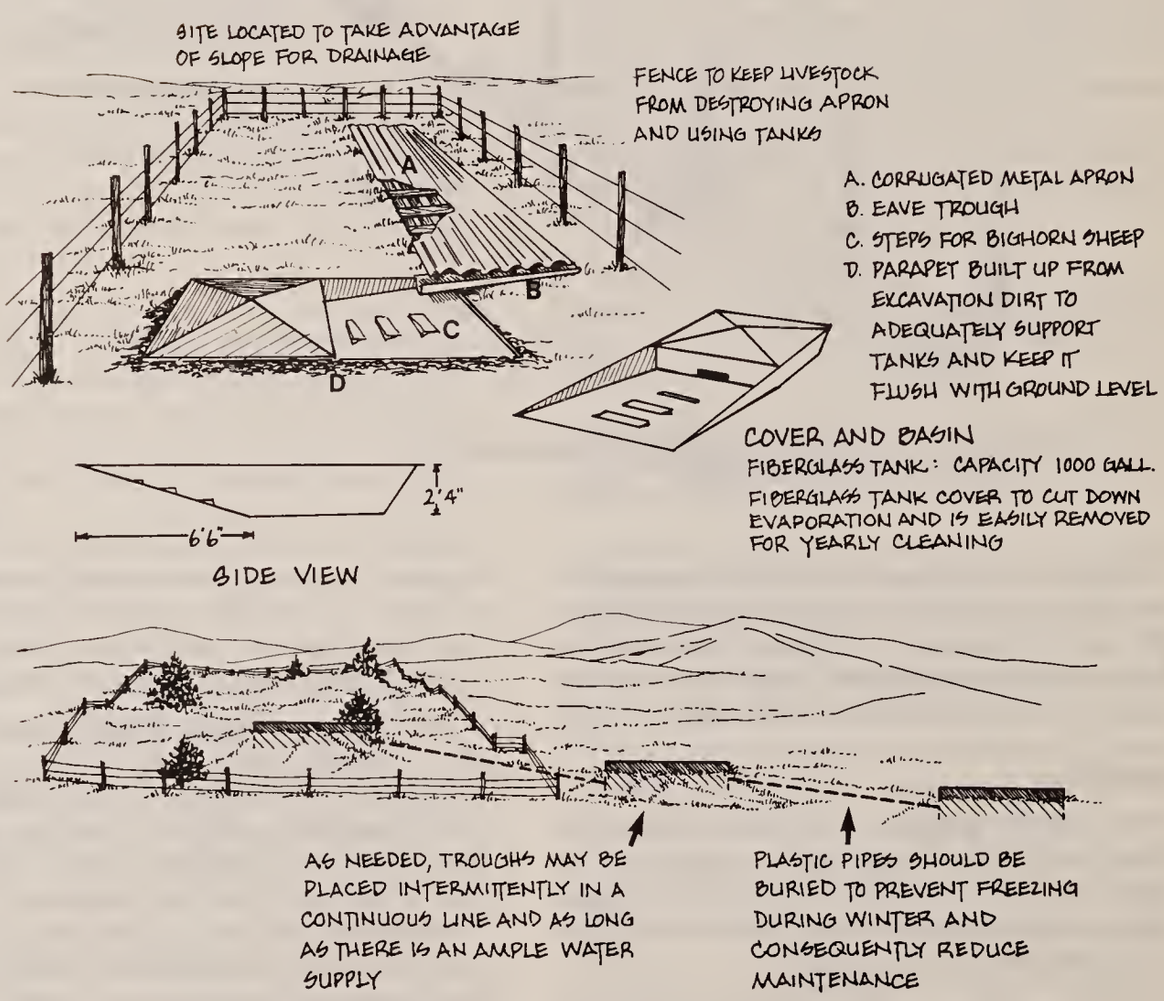

Figure 18.—Water developments that can be installed on bighorn sheep ranges include collection aprons with storage tanks and springs or seeps developed with troughs. (Adapted from Yoakum et al. 1980)

In the Great Basin, naturally occurring water is least available during hotter portions of the year, after surface water is gone, so impoundments should provide water during this period. Where possible, they should be shaded from the sun to reduce evaporation. Development of "permanent" water sources can make available areas that have all the other components of bighorn sheep habitat (Jones et al. 1957). During the colder portions of the year, water should be available in locations where it is least likely to freeze and where the animals are most likely to be, such as on south-facing slopes.

Care should be taken to ensure that watering devices will not trap or injure bighorn sheep (Mensch 1969). Periodic maintenance will be needed to keep such devices functioning (Jones et al. 1957).

The most desirable placement of water sources is at intervals of 3.2 kilometers (2 mi) and within 0.5 kilometer (0.3 mi) of escape terrain. Larger intervals will not allow bighorn sheep to use the habitat uniformly and will impose stress on the animals.

Creating water sources may increase conflict between bighorn sheep and other ungulates or people. Conditions detrimental to bighorn sheep that may result include severe grazing (Stelfox 1971); the potential for exchange of parasites or disease between bighorns and other ungulates, particularly domestic sheep (Bunch et al. 1978, Samuel et al. 1975); and degradation of water quality by mucking or defecation (Welles and Welles 1961; Wilson 1968, 1977).

Steps can be taken to remedy such problems. Conflicting species can be removed by trapping or killing. Existing waterholes can be fenced to exclude conflicting ungulate species (Morgan 1969, Schallenberger 1965, Trefethan 1975, Wilson 1977). Water sources can be developed in rugged topography that only bighorn sheep frequent, or other ungulates can be excluded by fences while bighorn sheep have access via escape terrain (Halloran and Deming 1958) (fig. 19). Water sources for livestock can be installed in areas distant from bighorn sheep habitat to attract livestock away from such habitat (McCollough et al. 1980).

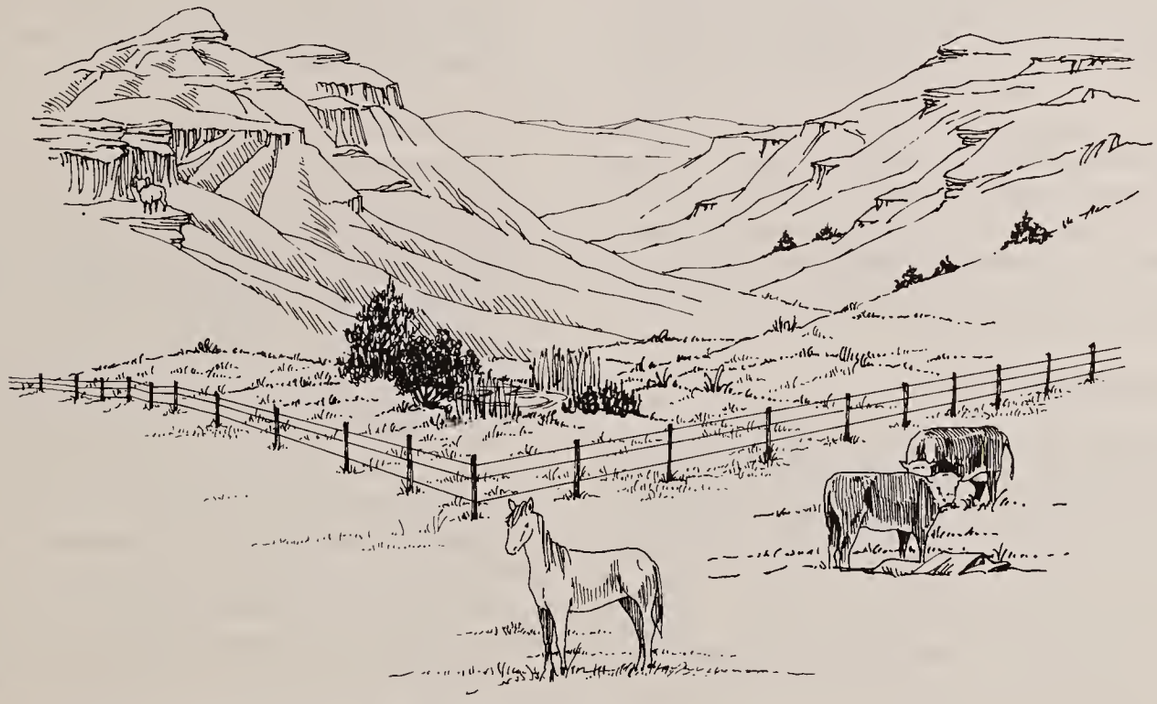

Figure 19.—Domestic and feral ungulates can be fenced away from a water source to preserve it for bighorn sheep.

Regular human activity can cause bighorn sheep to alter or terminate their use of water sources (Blong and Pollard 1968, Buechner 1960, Welles and Welles 1961). Where this occurs, special restrictions can be implemented for people and their equipment (Hicks and Elder 1979). For best results, water should be conserved and reserved for bighorn sheep through proper location and control of conflicting species.

THERMAL FACTORS

Thermal protection for bighorn sheep comes from two primary sources—vegetation and geomorphic features. These sources provide shade or reradiate heat. A manager must work with existing geomorphic features because they cannot be produced. Their effectiveness, however, can be enhanced by restricting human activity and insuring that water and forage are provided in close proximity to reduce travel for bighorns.

Where trees are lacking, or where trees and shrubs have dense or extensive canopies that discourage use by bighorn sheep, a manager can improve the thermal qualities or use of existing stands. Canopies that are too dense can be opened by prescribed burning or thinning. If, on the other hand, additional cover is needed, species compatible with the site, such as mountainmahognay or juniper, can be planted and livestock fenced out to allow seedlings to become established. In arid or semi-arid areas, growing trees or tall shrubs is a relatively slow process and providing thermal cover may require 10 to 30 years.

RUTTING AREAS

Human disturbance is detrimental to breeding. Restricting the use of roads, trails, or areas open to travel by people and controlling other management activities helps insure that breeding progresses normally. The rut is a critical part of the bighorn sheep's life cycle, and solitude is conducive to successful breeding. Excessive disturbance in any form may cause a decline in productivity.

If a bighorn sheep herd migrates to traditional areas for the rut (Geist 1971), it is of utmost importance that travel corridors to such areas be protected and maintained.

PARASITES AND DISEASES

Some of the factors responsible for the large reduction in the number of bighorn sheep since the turn of the century have been practically eliminated. Indiscriminate shooting has been curbed by tightly regulated and enforced hunting systems. In some cases, proper allocation of forage between bighorn sheep and other grazers has made sufficient forage available for bighorn sheep (Crump 1957, 1971; Stelfox 1971). But, parasites and diseases are still a threat.

Numerous parasites and diseases have been documented in bighorn sheep (Allen 1971, Becklund and Senger 1967). Species-specific parasites, such as lungworms and intestinal nematodes that have evolved with bighorn sheep play a natural role in regulating numbers and rarely decimate entire populations (Blood 1963b, Buechner 1960, Forrester 1971, Kistner et al. 1977, McCullough and Schneegas 1966). Other co-evolved parasites specific to bighorn sheep may not be detrimental to herd health (Allen 1971, Samuel et al.1978).

Although species-specific parasites and diseases may threaten bighorn sheep populations, some of the parasites and diseases contracted from domestic livestock are a greater threat. Although most parasites and diseases carried by domestic livestock do not appear to have undesirable effects on bighorn sheep, others apparently have been responsible for decimating entire herds. In most of these instances there was no direct evidence that domestic livestock were the source of the disease or parasite, but conditions prevailing at the time suggested that domestic livestock were the source. For example, bluetongue, a common disease of domestic sheep usually transmitted by insect vectors (Trainer 1970), was responsible for the death of a captive bighorn sheep in Texas (Robinson et al. 1967). Subsequently, the captive herd was

nearly wiped out by the disease.[3] Bluetongue also caused the death of several bighorn sheep from a herd in northern California (Campbell 1980). In both instances, domestic sheep had ranged in areas adjacent to those used by the bighorn sheep. Entire herds in California and Washington have recently been lost to bacterial pneumonia. The source of the disease probably was domestic sheep (Campbell 1980, Foreyt and Jessup 1982, Jessup 1980).

The sheep bot fly, usually associated with domestic sheep and occasionally with domestic goats and deer (Capelle 1971), has been reported in bighorn sheep (Capelle 1966). It was recently identified as a cause of mortality in desert bighorn sheep (Bunch et al. 1978). To date, there has been no satisfactory way to control the spread of the bot fly, whose life cycle can be completed in bighorn sheep.

The scab mite, which causes psoroptic mange, apparently can be carried by domestic livestock and at the turn of the century was thought to be responsible for significant losses of bighorn sheep. Although psoroptic mange has since been considered eradicated or controlled, it has recently been associated with losses of desert bighorn sheep in New Mexico (Lange 1980, Lange et al. 1980, Williams 1980). Because this mite can still have drastic effects on herds of bighorn sheep, the best prevention is to eliminate opportunities for its transmission from domestic livestock.

Contagious ecthyma (soremouth) has commonly been diagnosed in domestic and bighorn sheep (Blood 1971, Campbell 1980, Samuel et al. 1975). Although some biologists think this condition has minimal impacts on bighorn sheep (Blood 1971), it has been responsible for numerous deaths, primarily of lambs (Campbell 1980).

A species of lungworm common to domestic sheep was responsible for deaths in a captive herd of bighorn sheep (DeMartini and Davies 1976, 1977). The animals died from pnuemonia that developed only after they were infected by the lungworm.

Other parasites and diseases borne by domestic sheep that can be harmful to bighorn sheep include: helminths (Uhazy and Holmes 1970); coccidia (Uhazy et al. 1971); and pneumonia (DeMartini and Davies 1976, Howe et al. 1966, Parks et al. 1972). Pneumonia is serious only when bighorn sheep have suffered lung tissue damage or are subject to unusual physiological or psychological stress (DeMartini and Davies 1977, Woolf and Kradel 1973). Any herd of bighorn sheep can become stressed—by predators, by association or competition with livestock or humans, or by inclement weather (Foreyt and Jessup 1982, Parks et al. 1972).

Therefore, if bighorn sheep are to have the best opportunity to survive, they should be spatially separated as far as possible from domestic livestock to prevent contamination (Foreyt and Jessup 1982, Jessup 1980, Robinson et al. 1967) (fig. 20). This is especially important where flying insect vectors are involved. Attractants such as salt stations should be used sparingly because they tend to concentrate use by all ungulates and increase the possibility of disease transfer (Blood 1971, Samuel et al. 1975). Likewise, water sources and feeding stations should be placed so they are never used at any time by both domestic and bighorn sheep (fig. 21).

Pesticides can be used to retard or control some outbreaks of disease (Bunch et al. 1978). For example, the lungworms of bighorn sheep, and the land snails that are the lungworms' intermediate hosts, can be controlled by administering drugs or molluscicides and larvicides to animals or by applying the treatment to a range (Hibler 1976, 1977; Hibler and Spraker 1976). Bighorn sheep infested with scab mites have been injected with drugs to kill the mites and temporarily prevent reinfestation (Williams 1981). The difficult step is to catch the bighorns so they can be treated.

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[3] Thomas, Jack Ward, wildlife biologist, Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon, personal communication.

Figure 20.—Domestic sheep should be kept as far as possible from areas inhabited by bighorn sheep (photo by Walt Van Dyke, courtesy Oregon Department of Fish and Wildlife).

Figure 21.—Water sources and salt stations should be located so they are not used by both bighorn sheep and livestock (photo by Walt Van Dyke, courtesy Oregon Department of Fish and Wildlife).

PREDATION

Important predators of bighorn sheep in the Great Basin include cougar, bobcat, coyote, and golden eagle. Of these, the cougar is considered the most capable of killing bighorn sheep (Buechner 1960, Smith 1954). Most authors addressing this topic indicate that the number of animals taken by predators is usually of little consequence to healthy populations of bighorn sheep (Buechner 1960). Losses frequently can be attributed to a single predatory animal that can be selectively removed (Blaisdell 1961). Predators are most effective when locations of escape terrain or water limit sheep movement and allow predators to concentrate hunting effort in a small area (Blaisdell 1961, Light et al. 1967). The impact of predation must be evaluated on a herd-by-herd basis and appropriate action taken.

HUMAN IMPACTS

Even if all the individual components of a habitat are satisfactory, the habitat as a whole will be unsuitable for bighorn sheep if human use is excessive. Human intrusion reduces the number of bighorn sheep, by causing sheep to reduce or terminate their use of prime habitat, stop migration, or split large existing herds into smaller herds (Dunaway 1971, Ferrier 1974, Horejsi 1976, Jorgensen and Turner 1973, Light 1971, Rutherford 1972, Spalding and Bone 1969, Weaver 1972, Wehausen 1980, Welles and Welles (1961). Human activities responsible for declines in sheep use include hiking and backpacking (Blong and Pollard 1968, Dunaway 1971, Nelson 1966, Wehausen 1980, Welles and Welles 1961), snow skiing (Light 1971), and water skiing and fishing (Ferrier 1974). Additional causes of declines are motorbiking (DeForge 1972), driving 4-wheel vehicles (Jorgensen and Turner 1973), construction and use of highways (Ferrier 1974), urban development (Ferrier 1974), and recreational development (Spalding and Bone 1969). When bighorn sheep are pushed from prime to marginal habitat, mortality usually increases and productivitiy decreases (Thorne et al. 1978).

Some herds of bighorn sheep have become conditioned to human activity (Hicks and Elder 1979). For most herds, however, the amount of human activity they can stand varies with the herd and the type and amount of activity (Dunaway 1971, Light 1967, McQuivey 1978). Some herds have become conditioned to human activity (Hicks and Elder 1979). For example, biweekly encounters between bighorn sheep and humans may have no measurable effects; whereas, daily encounters may cause sheep to discountinue use of an area.

Roads have an important association with human activity (Ferrier 1974). Although roads themselves are not necessarily detrimental to bighorn sheep, they greatly facilitate human access (fig. 22). Backcountry roads that receive little use may have little or no effect, but other roads have caused bighorn sheep to alter traditional migration routes (Ferrier 1974). Roads must be individually evaluated. If human access is detrimental, it can be controlled through road closures. When bighorn sheep are on summer range, human use of roads on their winter range will have little effect. The opposite is also true. Where bighorn sheep occupy year-long ranges, permanent road closures should be considered.

Road closures may not be feasible when bighorn sheep ranges lie adjacent to major roads or highways, but restricting off-road use of such areas may be feasible.

Remote, roadless bighorn sheep ranges sometimes receive heavy daily use from hikers and backpackers. In such situations, closures or restrictions may be required.

Land developments such as resorts, housing subdivisions, private dwellings, and hydroelectric installations, and activities such as mining, logging, and road construction, cause bighorn sheep to alter their use of habitat (Ferrier 1974, McQuivey 1978, Sugden 1961, Yoakum 1971). If the management objective is to maintain bighorn sheep, a careful evaluation of potential habitat alteration and human activity is critical to the planning process. For the most part, bighorn sheep now exist in the wild because of human decisions, and the fate of the species in the Great Basin of southeastern Oregon and other areas will be determined by future management of public lands (fig. 23).

Figure 22.—Roads through prime bighorn sheep habitat increase human access and associated negative impacts (photo by Walt Van Dyke).

Figure 23.—The future of bighorn sheep depends on the response of people to the bighorns's needs (photo by Walt Van Dyke, courtesy Oregon Cooperative Wildlife Research Unit).

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Appendix

Common and Scientific Names[1]

Common name	Scientific name
MAMMALS	
Bighorn sheep	*Ovis canadensis*
California bighorn sheep	*Ovis canadensis californiana*
Cougar	*Felis concolor*
Coyote	*Canis latrans*
Deer	*Odocoileus* spp.
Desert bighorn sheep	*Ovis canadensis nelsoni*
Domestic cow	*Bos taurus*
Domestic goat	*Capra hircus*
Domestic sheep	*Ovis aries*
Horse	*Equus caballus*
North American elk	*Cervus elaphus*
Pronghorn	*Antilocapra americana*
Rocky Mountain bighorn sheep	*Ovis canadensis canadensis*
BIRDS	
Golden eagle	*Aquila chrysaetos*
PLANTS	
Antelope bitterbrush	*Purshia tridentata*
Arrowleaf balsamroot	*Balsamorhiza sagittata*
Aspen	*Populus* spp.
Basin big sagebrush	*Artemisia tridentata tridentata*
Bearded bluebunch wheatgrass	*Agropyron spicatum*
Big sagebrush	*Artemisia tridentata*
Black greasewood	*Sarcobatus vermiculatus*
Black sagebrush	*Artemisia nova*
Blue elderberry	*Sambucus cerulea*
Bluegrasses	*Poa* spp.
Bolander silver sagebrush	*Artemisia cana bolanderi*
Bottlebrush squirreltail	*Sitanion hystrix*
Bud sagebrush	*Artemisia spinescens*
Cheatgrass brome	*Bromus tectorum*
Cherry	*Prunus* spp.
Chokecherry	*Prunus virginiana*
Cinquefoil	*Potentilla fruiticosa*
Cleftleaf sagebrush	*Artemisia arbuscula thermopola*
Cobre rockcress	*Arabis cobrensis*
Common snowberry	*Symphoricarpus albus*
Common winterfat	*Eurotia lanata*
Cottonwood	*Populus* spp.
Creambush rockspirea	*Holodiscus discolor*
Curlleaf mountain-mahogany	*Cercocarpus ledifolius ledifolius*

[1] Mammal names from Chapman and Feldhammer (1982); bird names from American Ornithologist's Union (1957); plant names from Garrison et al. (1976); parasite and disease names from Davis et. al. (1970).

Appendix (continued)

Common name	Scientific name
Currant	*Ribes* spp.
Cushion buckwheat	*Eriogonum ovalifolium*
Douglas-fir	*Pseudotsuga menziesii*
Early low sagebrush	*Artemisia longiloba*
Erigeron	*Erigeron* spp.
Fairway crested wheatgrass	*Agropyron cristatum*
Fir	*Abies* spp.
Fourwing saltbush	*Atriplex canescens*
Giant wildrye	*Elymus cinereus*
Idaho fescue	*Festuca idahoensis*
Indian ricegrass	*Oryzopsis hymenoides*
Juniper	*Juniperus* spp.
Lomatium	*Lomatium* spp.
Low sagebrush	*Artemisia arbuscula arbuscula*
Lupine	*Lupinus* spp.
Mallow ninebark	*Physocarpus malvaceus*
Meadow barley	*Hordeum brachyantherum*
Milkvetch	*Astragalus* spp.
Mountain big sagebrush	*Artemisia tridentata vaseyana*
Mountain-mahogany	*Cercocarpus* spp.
Mountain silver sagebrush	*Artemisia cana* sub. *viscidula*
Mountain snowberry	*Symphoricarpus oreophilus*
Penstemon	*Penstemon* spp.
Phlox	*Phlox* spp.
Pine	*Pinus* spp.
Pinegrass	*Calamagrostis rubescens*
Pinnate tansymustard	*Descurainia pinnata*
Prairie junegrass	*Koeleria cristata*
Quaking aspen	*Populus tremuloides*
Rabbitbrush	*Chrysothamnus* spp.
Rose	*Rosa* spp.
Sagebrush	*Artemisia* spp.
Saskatoon serviceberry	*Amelanchier alnifolia*
Sedge	*Carex* spp.
Shadscale saltbush	*Atriplex confertifolia*
Shinyleaf spiraea	*Spiraea lucida*
Spiny hopsage	*Atriplex spinosa*
Squaw apple	*Peraphyllum ramosissimum*
Subalpine big sagebrush	*Artemisia tridentata* form *spiciformis*
Threetip sagebrush	*Artemisia tripartata*
Thurber's needlegrass	*Stipa thurberiana*
Wallflower phoenicaulis	*Phoenicaulis cheiranthoides*
Western juniper	*Juniperus occidentalis*
Wild buckwheat	*Eriogonum* spp.
Willow	*Salix* spp.
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*
Yarrow	*Achillea millefolium*

Appendix (continued)

Common name	Scientific name
	PARASITES AND DISEASES
Bacteria	*Corynebacterium pogenes*
	Pasteurella multocida
Lungworms	*Muelleruis* sp.
	Protostrongylus stilesi
	Protostrongylus rushi
Nematodes	*Nematodirus* spp.
	INSECTS
Scab mite	*Psoroptes ovis*
Sheep bot fly	*Oestrus ovis*

*GPO 597 - 366 1985

Riparian Zones

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United States
Department of
Agriculture

Forest Service

United States
Department of
the Interior

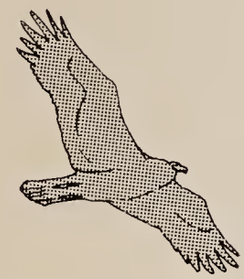
Bureau of
Land Management

General Technical
Report PNW-80

1979

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Riparian Zones



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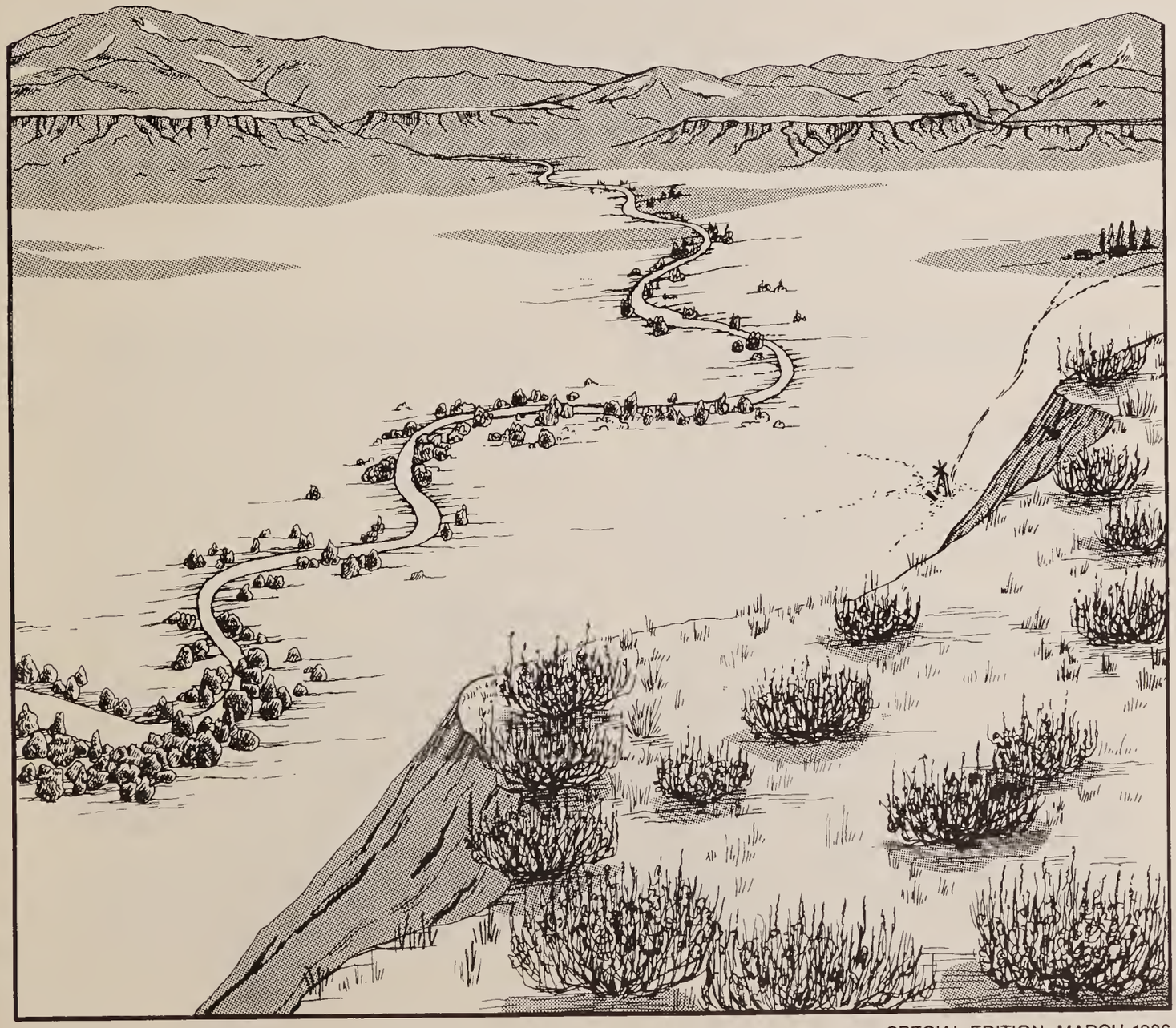

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ABSTRACT

Riparian zones are the most critical wildlife habitats in managed rangelands. More wildlife species depend entirely on or spend disproportionately more time in this habitat than any other. The zone is also disproportionately important for grazing, recreation, timber production, fisheries production, road location and water quality and quantity. The importance to wildlife is examined and guidance given for management.
KEYWORDS: Riparian habitat, wildlife habitat.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of Southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Riparian zones can be identified by the presence of vegetation that requires free or unbound water or conditions that are more moist than normal (fig. 1) (Franklin and Dyrness 1973, Minore and Smith 1971). Riparian zones can vary considerably in size and vegetative complex because of the many combinations that can be created between water sources (fig. 2) and physical characteristics of a site. Such characteristics include gradient, aspect, topography, soil, type of stream bottom, water quality, elevation, and plant community (Odum 1971). All riparian zones within managed rangelands of the western United States, however, have the following in common: (1) they create well-defined habitat zones within the much drier surrounding areas; (2) they make up a minor proportion of the overall area; (3) they are generally more productive in terms of biomass—plant and animal—than the remainder of the area; and (4) they are a critical source of diversity within rangelands (fig. 3). Carothers (1977), Carothers and Johnson (1975), and Curtis and Ripley (1975) have prepared summary papers on the subject of riparian habitats as associated with both range and forest areas.

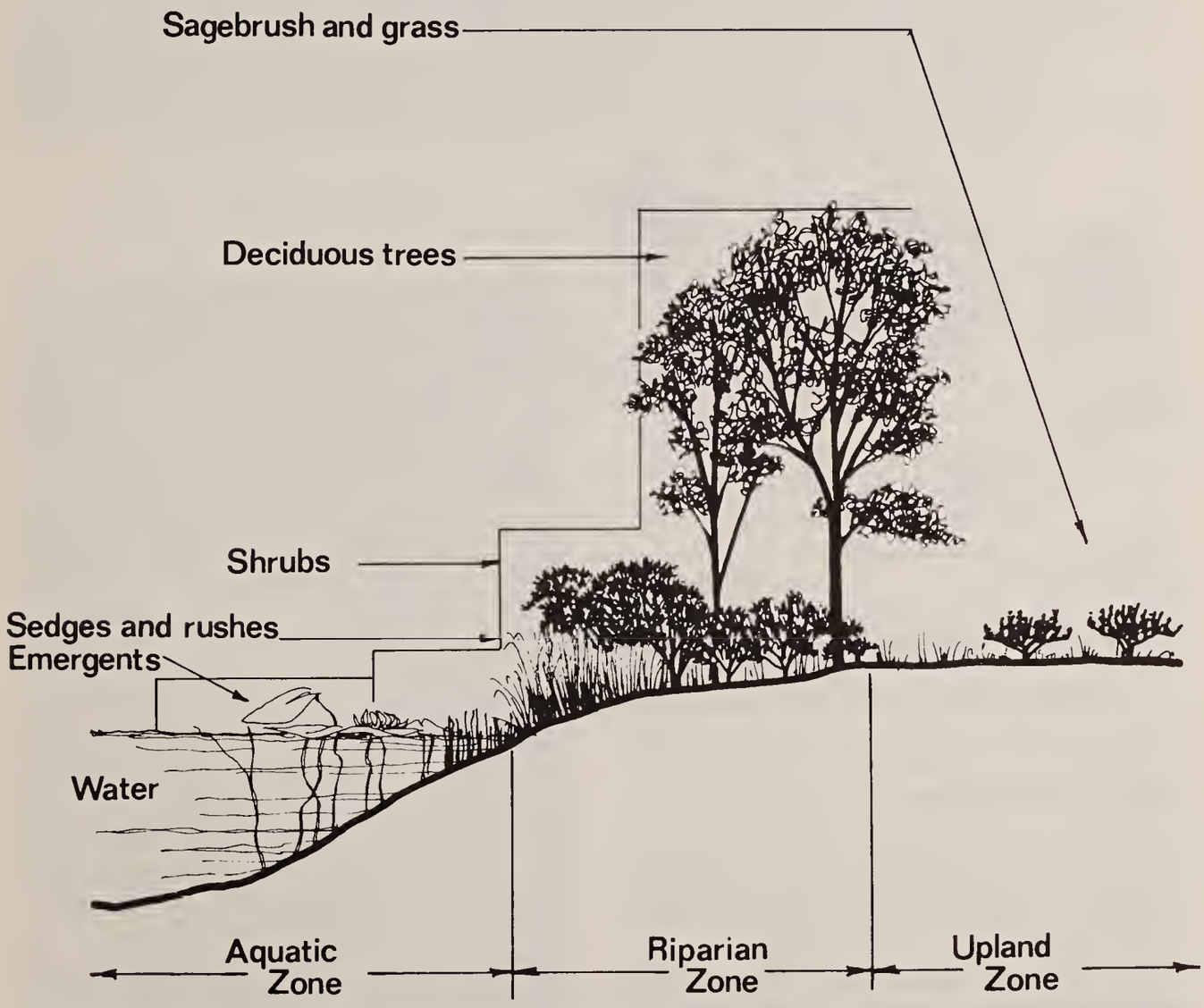


Figure 1.—Riparian zones are identified by the presence of vegetation that requires large amounts of free or unbound water.

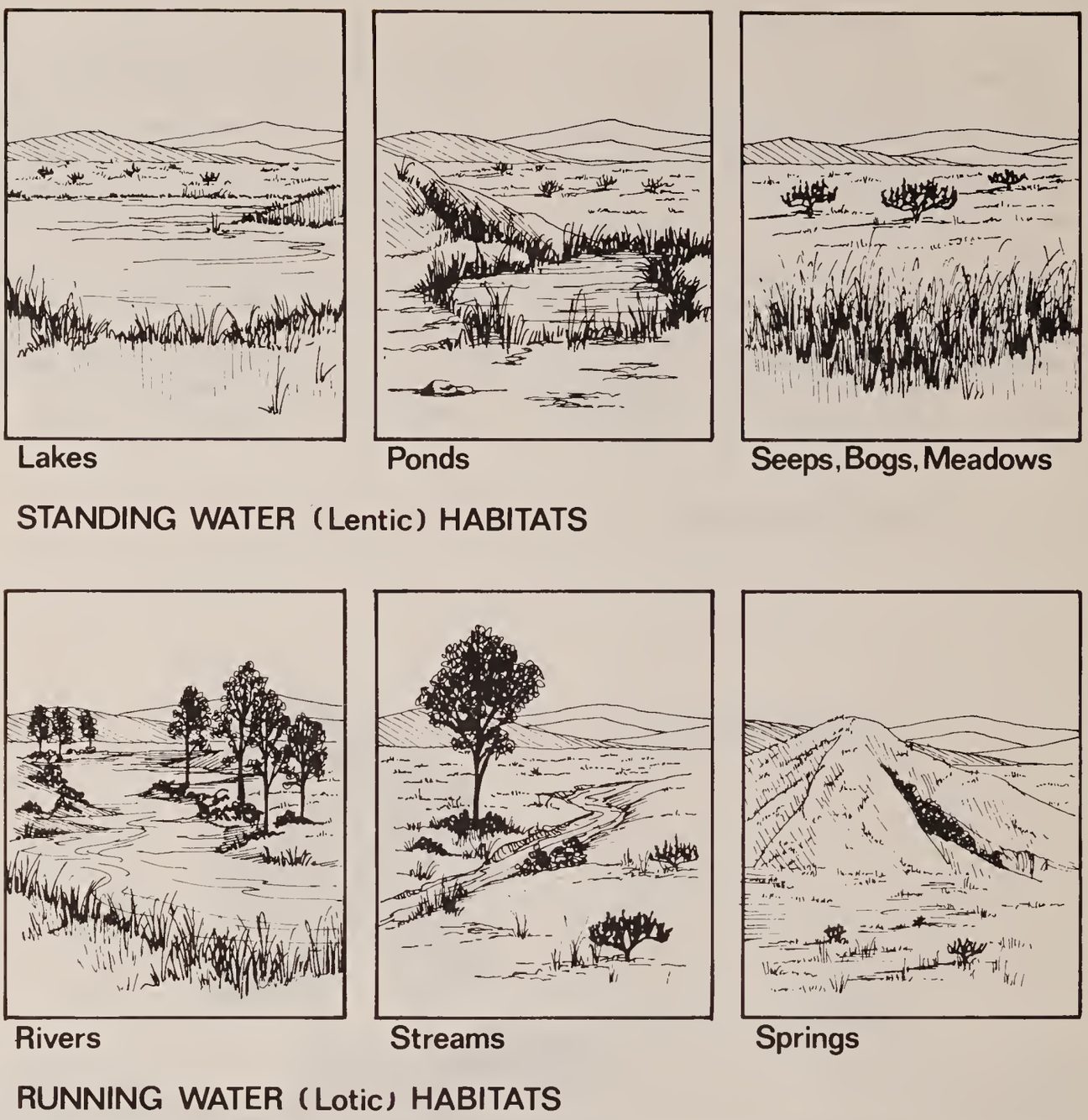


Figure 2.—The type of water source influences riparian vegetation (Odum 1971, p. 295).

IMPORTANCE OF RIPARIAN ZONES

Wildlife use riparian zones disproportionately more than any other type of habitat (Beidleman 1948 and 1954, Bottorff 1974, Dumas 1950, Gains 1977, Hinschberger 1978, Hubbard 1977, Kelley et al. 1975, Kirby 1975, and Wooding 1973). For example, of the 363 terrestrial species known to occur in the Great Basin of Southeastern Oregon, 288 are either directly dependent on riparian zones or utilize them more than other habitats (fig. 4). Many aquatic and semi-aquatic species are found nowhere else. Among such species are waterfowl and mammals, such as otter (*Lutra canadensis*), beaver (*Castor canadensis*), and muskrats (*Ondatra zibethicus*). Vertebrates that either reproduce or feed in water are totally dependent on riparian and adjacent

Figure 3.—Riparian zones are a critical source of diversity on western managed rangelands. Note the beaver (*Castor canadensis*) lodge in the upper right of the picture. (Robert R. Kindschy photograph).

aquatic zones. Of course, the water in these zones is the habitat for aquatic life forms—from invertebrates to fish, reptiles, amphibians, birds, and mammals. In short, riparian zones are the most critical wildlife habitats in managed rangelands.

Riparian zones in managed rangelands are also disproportionately important for other uses (fig. 5). Stream margins frequently contain highly productive forage sites. Cattle use the vegetation in riparian areas more heavily than that in other areas (Ames 1977, Kennedy 1977) because they concentrate in riparian areas to drink. The relative gentle topography, particularly in areas of otherwise rugged topography, makes riparian zones attractive for road locations. Streams, rivers, and their banks are also handy sources of rock and gravel for building roads. Mining has and does have direct and indirect impacts on riparian zones (Hill 1974) (fig. 6). Recreationists concen-

Figure 4.—Wildlife uses riparian zones disproportionately more than any other habitat type. (Robert R. Kindschy photograph).

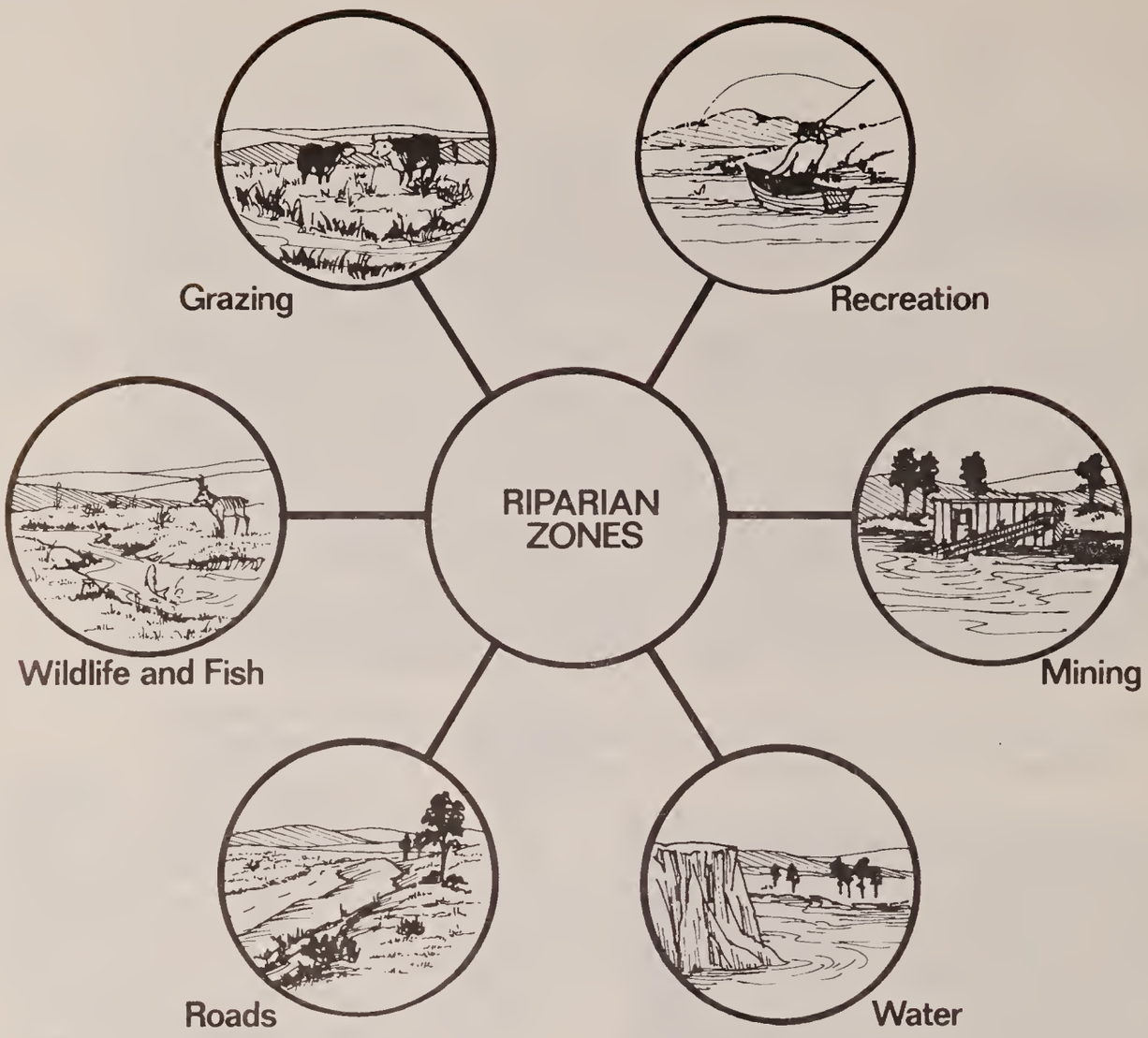


Figure 5.—Riparian zones are disproportionately important to many uses which makes them the most critical zones for multiple-use planning.

trate their use in such areas (Nash 1977). In addition, scenic values are often high. The water in such zones, particularly on dry western ranges, is critical to man's use, and rangelands are second only to cultivated lands as a source of water quality problems (Satterlund 1975). As a result, riparian zones are the most critical zones for multiple-use planning (Countess et al. 1977, Fox 1977, Lewis and Marsh 1977, Likens and Bormann 1974, Tuinstra 1967).

There are many reasons why riparian zones are so important to wildlife. Not all of these can be attributed to every riparian zone. Each combination of water source, site attributes, and management objectives must be considered separately by range managers. Some of these reasons are discussed below:

1. The presence of water lends importance to the zone. Wildlife habitat is composed of food, cover, and water. All riparian zones offer water, one of the critical habitat components, and some offer all three.

2. The greater availability of water to plants, frequently in combination with deeper soils, increases plant biomass production and provides a suitable site for plants that are limited elsewhere by inadequate water

Figure 6.—Mining activity has been frequently located in or adjacent to riparian zones causing severe disturbance. (Robert R. Kindschy photograph).

(Minore 1970, Minore and Smith 1971). In combination, these factors frequently lead to increased diversity of plant species and structural diversity in the community. Much of the diversity in species composition is accounted for by the presence of plants particularly adapted to wet or moist conditions, particularly those provided by surface as opposed to ground water (Campbell and Green 1968, Horton 1972, Maximov 1931). In the management sense, this means that riparian zones generally have a high rate of recovery or successional advancement of the vegetation when afforded proper conditions by protection or appropriate management.

3. The dramatic contrasts of the plant complex of the riparian zone with the general surrounding upland range vegetation adds to the structural diversity of the area (Jain 1976). For example, open wet meadows or groves of deciduous trees around seeps provide edges with stark contrast when they, in turn, are surrounded by relatively drier grasslands or shrublands. Moreover, those riparian zones dominated by deciduous vegetation provide one type of habitat during the summer when in full-leaf and another type of habitat during the winter following leaf-fall (Anderson and Ohmart 1977).

4. The shape of many riparian zones, particularly the linear nature of streams, maximizes the development of edge which is so productive of wildife (Bottorff 1974, Patton 1975). In those cases where streams flow through canyons, the canyon walls combine with the riparian zone to provide a unique habitat complex (fig. 7).

5. Riparian zones in rangelands frequently produce more edges within a small area than would be expected elsewhere (fig. 8). In addition, there are many vegetative strata exposed in stair-step fashion (fig. 8). This stair stepping of vegetation of contrasting form (deciduous vs. coniferous; shrubs vs. trees) provides diverse nesting and feeding opportunities for wildlife—especially birds and bats. The association of particular birds with distinct layers of vegetation has been repeatedly demonstrated (Dambach 1944, Lack 1933, MacArthur et al. 1962, Preston and Norris 1947, Thomas et al. 1977). In addition, birds have been shown to select between coniferous and deciduous vegetative volumes in distinct strata (DeGraaf 1976 and Thomas 1973).

Figure 7.—Where streams run through steep canyons, the cliff faces and the riparian zones combine to form a unique habitat unit. (Bureau of Land Management photograph).

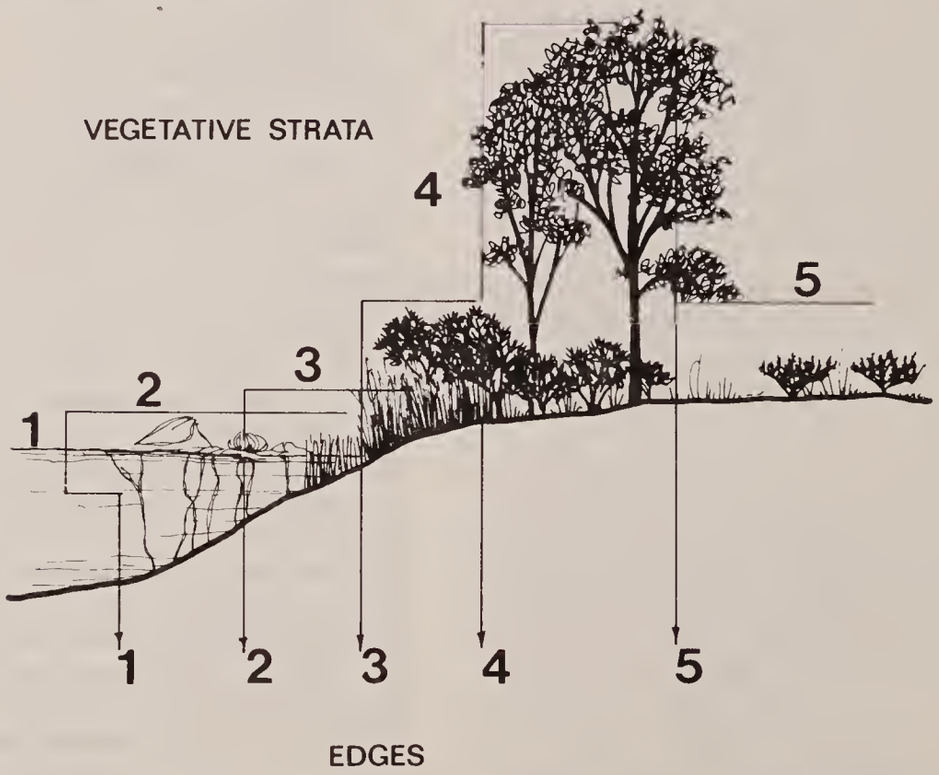


Figure 8.—Riparian zones frequently have a high number of edges and strata in a comparatively small area. This produces habitat for a greater number of species, reflecting the diversity of plant species and community structure.

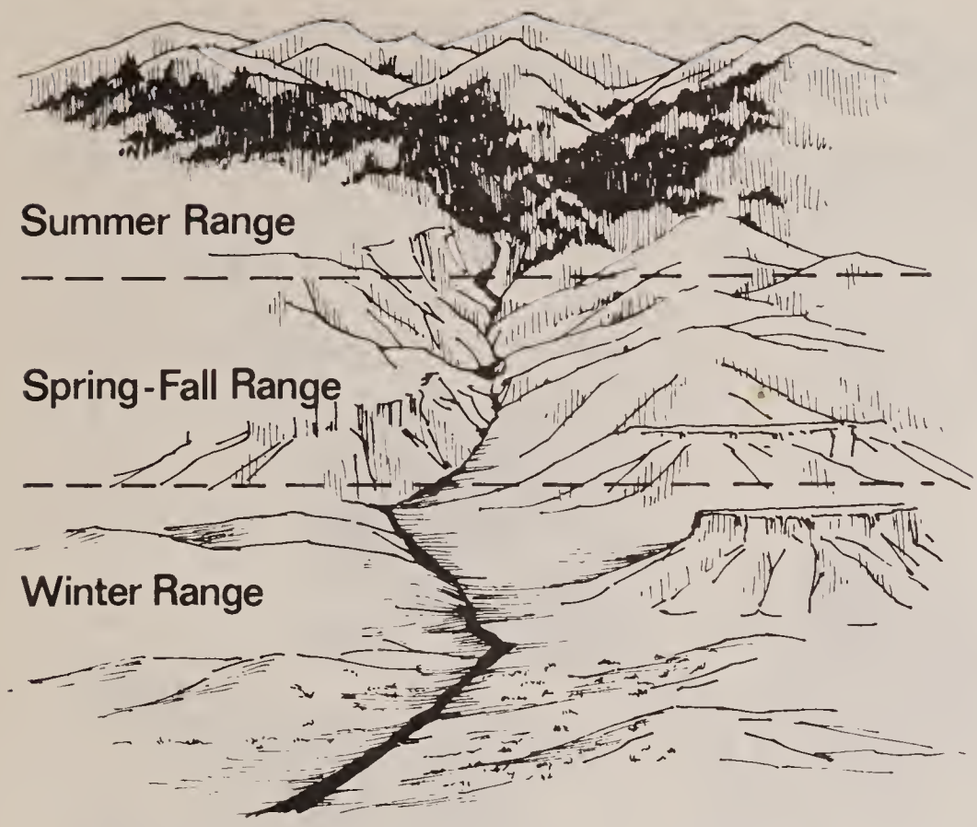


Figure 9.—Riparian zones along rivers and streams are frequently used as migration routes by wildlife. A migration corridor used by mule deer (*Odocoileus hemionus*) between summer range at high elevation and winter range at low elevation is illustrated.

6. The microclimate of riparian zones is different from that of the surrounding rangelands due to increased humidity, a higher rate of transpiration, more shade, and increased air movement. Some wildlife species are attracted to this microclimate. Mule deer (*Odocoileus hemionus*) spend a disproportionate amount of time in such areas due to the presence of cover that helps to maintain homeostasis or a condition where energy expenditure is minimized (see Thomas et al. 1979b for a review of this concept). The attraction of deer, elk, and other wild and domestic ungulates to these areas is caused by the abundance of thermal cover and the microclimate produced by that vegetation.

7. Riparian zones along intermittent and permanent streams and rivers provide migration routes for wildlife, such as birds, bats, deer, and elk (Stevens et al. 1977, Wauer 1977). In the case of deer and elk, such areas are frequently used as travel corridors between high elevation summer ranges and low elevation winter ranges (fig. 9).

8. Riparian zones, particularly along rivers and streams, may serve as forested connectors between habitats. Wildlife may use such riparian zones for cover while traveling across otherwise open areas. Some species, especially small mammals and birds may use such routes in dispersal from their original habitats caused by population pressure or food, water, or other shortage. The riparian zones provide cover and often provide food and water during such movements (fig. 10).

SENSITIVITY TO DISTURBANCE

Riparian zones occupy relatively small areas and should be considered vulnerable to severe alteration. Because of the distinct vegetative community and the structure of riparian zones, they must also be considered fragile. The more mature the vegetative complex of the riparian zone, the more apt it is to assume distinct edges and strata that intensify edge-effect and increase diversity. This mature condition is sensitive to management activities that occur within the riparian zone itself or on the surrounding rangeland (fig. 11).

The sensitivity of the vegetatively mature riparian zone as wildlife habitat can also be attributed to its distinct microclimate. Such

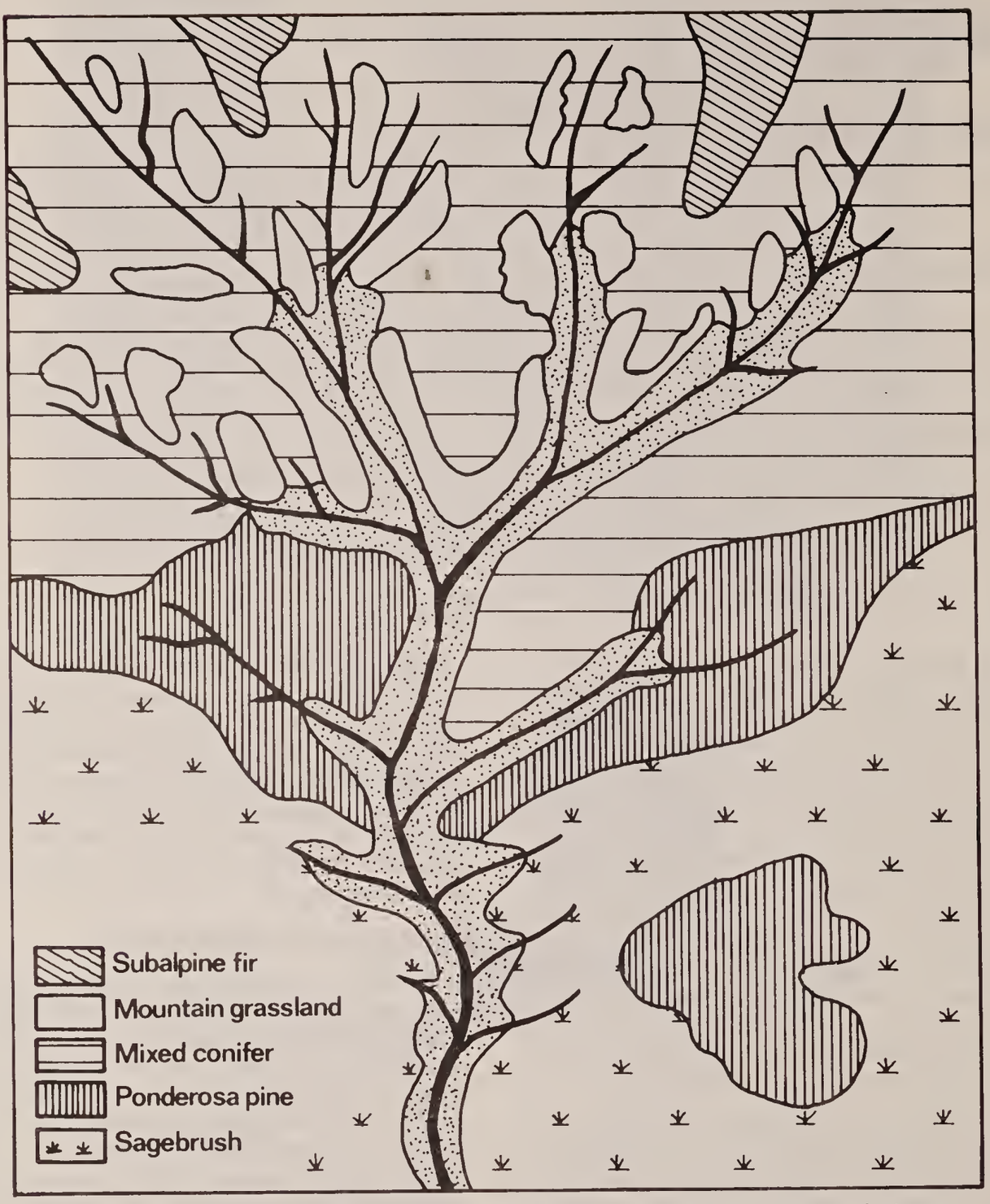
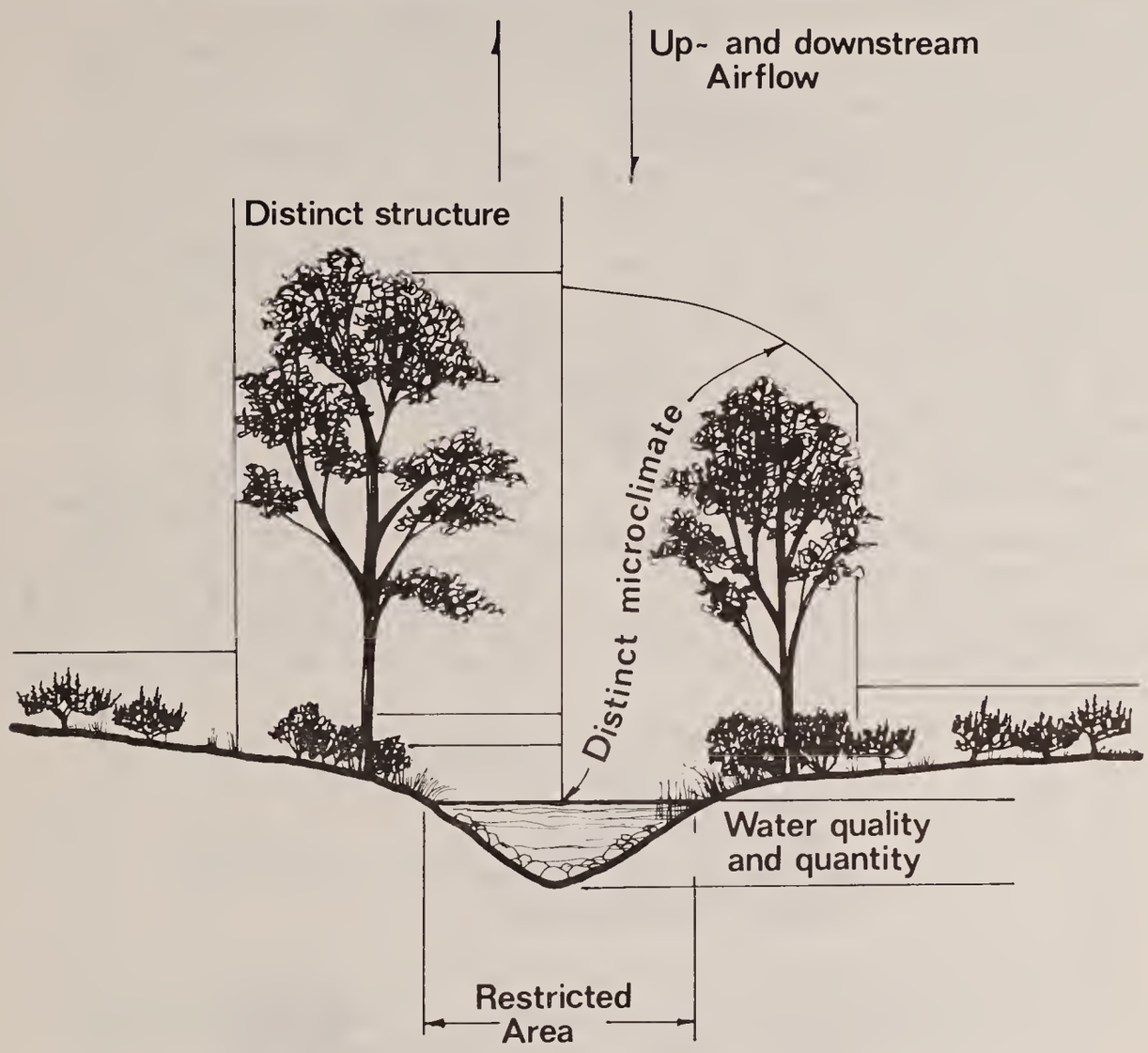


Figure 10.—Riparian zones along rivers and streams serve as connectors between habitat types; they provide cover, food, and water as the animals move from one location to another.

Figure 11.—Riparian zones must be considered as "delicate" due to the combination of restricted area, distinct microclimate, vegetative structure and composition, and water quantity and quality.



sensitivity includes both the terrestrial portions of the riparian zone and the characteristics of water quality (including temperature) of the associated aquatic zone (Boussu 1954, Gunderson 1968, Tuinstra 1967). Changes in the canopy cover can alter these characteristics markedly (Brown et al. 1971, Brown and Krygier 1967, Collings and Myrick 1966, Cordone and Kelley 1961, Meehan 1970). For example, an increase of a few degrees in water temperature may eliminate a stream as a trout fishery.

MANAGEMENT CONSIDERATIONS

Riparian zones are so different from one another that generalized animal-to-habitat relationships are difficult to develop for these areas. To do a good management job with such areas, one must derive a specific set of relationships for each particular case. Rangeland managers should consult both fishery and wildlife biologists when management activities are planned within the riparian zone. The following considerations can be helpful:

1. Road construction in riparian zones will lessen the effectiveness of the zone as habitat for many wildlife species (fig. 12). This results from both the alteration in the vegetative complex and in the increased disturbance from traffic along the road. Increased sedimentation from road construction may be detrimental to water quality and hence to aquatic life. Many streams in managed rangelands are already paralleled by roads. Each time a new streamside road is considered, managers need to determine how much riparian habitat will be seriously impaired by such roads. This can be done by comparing the percent of streams with roads alongside of them with the percent of streams without roads. Road construction probably has a more critical and long-lasting impact on riparian zones than any other management activity.

2. The narrower the riparian zone the more easily it is altered by management action.

3. Construction of campgrounds in riparian zones enhances the opportunity for human-wildlife contacts but simultaneously decreases effectiveness of the riparian zone as wildlife habitat due to the disturbance by humans, trampling, soil erosion, compaction, and loss of vegetation (Aitchison 1977, Aitchison et al. 1977, Settergren 1977).

4. Improper grazing practices in riparian zones can reduce water quality, eliminate streamside shrubs, cause soil compaction, accelerate erosion, and breakdown streambanks (Ames 1977, Buckhouse and Gifford 1976, Coltharp and Darling 1973, Diesch 1970, Marcuson 1977, Winegar 1975). Proper grazing management should include particular attention to insuring the welfare of riparian zones.

If livestock grazing is to take place in a riparian zone, the environmental impact on the zone should be carefully evaluated. The heavier the grazing and the more prolonged the grazing period the more severe will be the impacts (fig. 13). The environmental impacts of grazing in such zones may be magnified be-

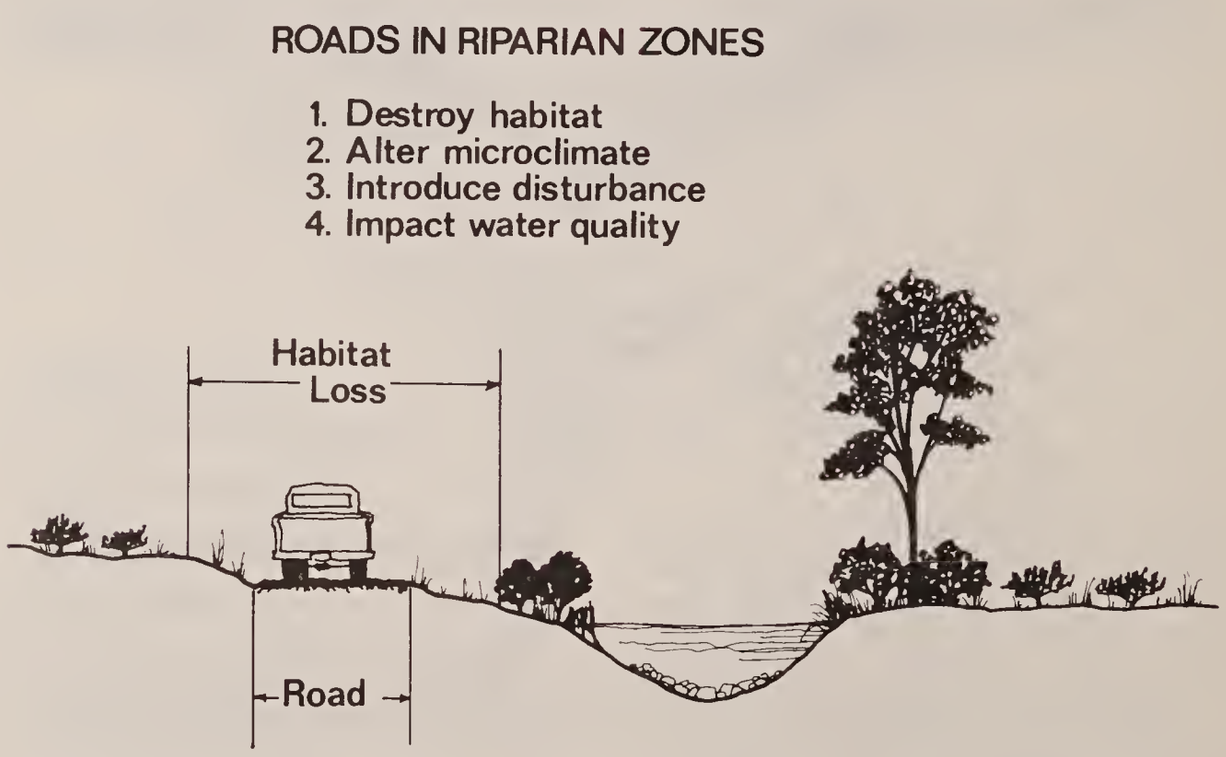


Figure 12.—Road construction in riparian zones reduces their usefulness as wildlife habitat. Roads in riparian zones: (1) alter vegetative structure, (2) alter microclimate, (3) reduce the size of riparian zones, (4) disturb the wildlife, (5) impact water quality in the aquatic zone, and (6) destroy the wildlife habitat.

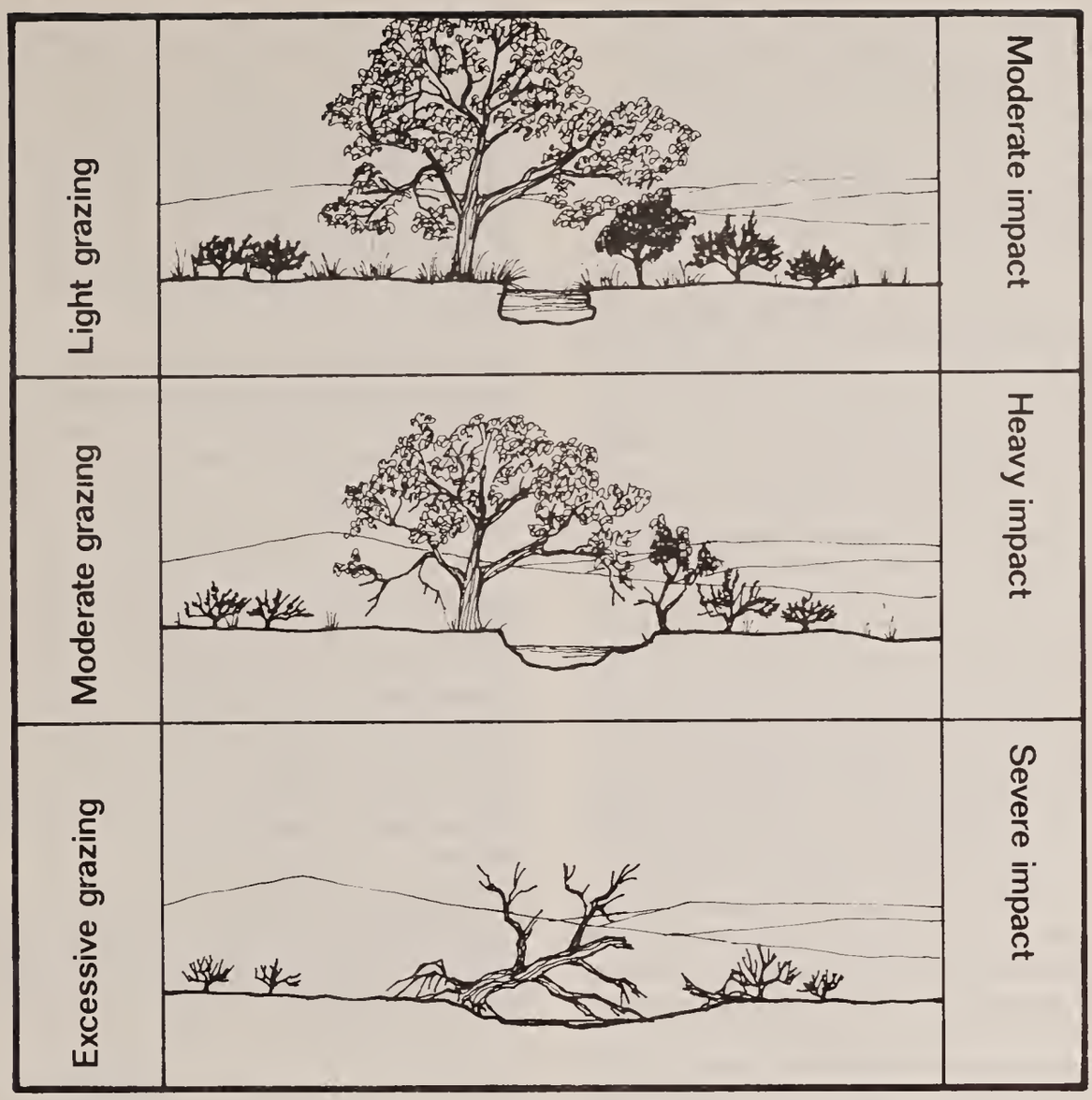


Figure 13.—When livestock are grazed in riparian zones, consideration of environmental impact is even more important than usual.

cause of the sensitivity of the microclimate and water temperature to increases in solar radiation reaching the ground or water surface. Some erosion disturbances are multiplied by proximity to the riparian zone. The key to prevention of surface erosion is the prevention or lessening of overland flow which is related to infiltration of precipitation. Infiltration may be enhanced by the maintenance of plant cover, both alive and dead. Under excessive grazing, livestock not only remove protective ground cover but also compact the soil, both of which accelerate erosion (Dambach 1944, Satterlund 1975).

Springs and seeps are often associated with relatively small, wet meadows. These meadows are critical to the existence of animals such as the montane vole (*Microtus montanus*) which, in turn, is food for many other vertebrates. Satterlund (1975, p. 24) observed:

> Meadows along stream channels are likely to be among the most productive parts of the range [in terms of livestock forage] because of the greater amount of water available for plant growth. Further, this same

moistness makes them more susceptible to compaction. And finally, most animals [livestock] prefer to stay near available water, so this area receives the greatest impact of animal use. Therefore, these areas are key considerations in the prevention of erosion.

Development of seeps and springs for livestock (collecting the water into tanks and troughs) usually lessens the habitat value for wildlife (Heady and Bartolome 1977, USDA Soil Conservation Service 1967). When developing seeps and springs, one can increase values to wildlife by fencing the meadow surrounding a spring or seep to exclude livestock and piping the necessary water outside of the exclosure into troughs or other storage facilities (fig. 14). Small, wet meadows can also be created by piping overflow water from livestock troughs into fenced areas thereby creating and maintaining such meadows. A combination of the above techniques will provide the greatest area of "wet" habitat and, therefore, the greatest production of these rare and highly productive wildlife habitats.

5. Location of water impoundments are important if maximum benefits to wildlife are to be realized. Some areas which potentially receive the heaviest animal use are mature and decadent stands of western juniper (*Juniperus occidentalis*) and curlleaf mountain-mahogany (*Cercocarpus ledifolius*), cliffs, and edges between plant communities or structural conditions within plant communities (Maser et al. 1979, Maser and Gashwiler 1978, Thomas et al. 1978, Thomas et al. 1979c). Where water is a limiting factor, wildlife habitat may be created or enhanced by proper placement and design of water impoundments.

6. Although man-caused debris should be removed, a water source should not be "overcleaned." Leave moderate amounts of stable debris intact since it serves as critical, small habitats—usually for reproduction of small animals.

7. Recreational use per unit area of the riparian zone is many times that of other vegetative types (Heberlein 1977, Lewis and Marsh 1977, USDA Forest Service 1977). The impact of such use on wildlife varies with the season and type, intensity, and duration of use (Kuska 1977, Pfister 1977). Construction of trails, picnic tables, and docks encourages recreational use and increases the potential for conflicts with wildlife welfare.

8. Range management activities that take place outside the riparian zone may have impact on the riparian zone itself by changing the quantity and quality of water entering and in-

Figure 14.—Wildlife habitat can be maintained and/or enhanced by fencing a meadow surrounding a spring or seep to exclude livestock. The necessary water can then be piped outside of the exclosure into troughs, and by piping overflow water from livestock troughs into fenced areas, small, wet meadows can be created and maintained.

fluencing the riparian zones (Buckhouse 1975, Environmental Protection Agency 1976). Of the many factors that influence the amount of surface erosion and subsequent water quality, some can be controlled through management action, and the most important action is the maintenance of appropriate vegetative cover and soil conditions (Satterlund 1975). These influences may involve changes in suspended solids, nutrients, electrical conductance, and minerals as well as water temperature and water volume (Hibbert et al. 1974, 1975, Sharpe 1975). Leopold (1941, p. 17) put it this way: "Soil and water are not two organic systems, but one. Both are organs of a single landscape; a derangement in either affects the health of both...."

9. Any grazing management scheme that is instituted with the idea of preserving, enhancing, or reestablishing woody vegetation along streamsides or other riparian zones must consider the physiology of these plants and their response to grazing. Standard grazing systems, such as continuous rest rotation or deferred rotation (Heady 1975), in various forms, have generally been developed considering only the production and maintenance of forage plants—primarily grasses and forbs. It is likely that the application of such systems to maintain woody streamside vegetation and streambank integrity will not be satisfactory until the physiology of shrubs and trees is given consideration equal to forage plants.

Information on how grazing systems may be used to accomplish such goals as maintenance of woody streambank vegetation and the prevention of bank crumbling and soil compaction is only now being derived by experience and research. It is likely that special systems may have to be instituted, such as six or more pastures in the rotation grazing systems (compared to the presently standard two to five pastures) or complete protection for some period coupled with restricted grazing after satisfactory conditions are achieved.

"Business as usual" has resulted in deterioration of many riparian wildlife and fish habitats. New approaches to grazing management in riparian zones may be required to restore or maintain the fish and wildlife habitat values of this most critical zone.

A "RED FLAG" FOR RIPARIAN ZONES

The riparian zone is the most important wildlife habitat type in the managed rangelands. It is also the area of maximum potential conflict between users of timber, grazing, recreation, water, and wildlife resources. Riparian zones are usually quite sensitive to management activities and should be cautiously managed (Beschta 1978). As each riparian zone is somewhat different, the land manager should consult a wildlife biologist and a fishery biologist during the planning process if fish and wildlife welfare are objectives of management. The purpose of this chapter has been to raise a "red flag" where riparian zones are concerned. Habitat alterations will affect wildlife far more than indicated by the proportion of the total area disturbed.

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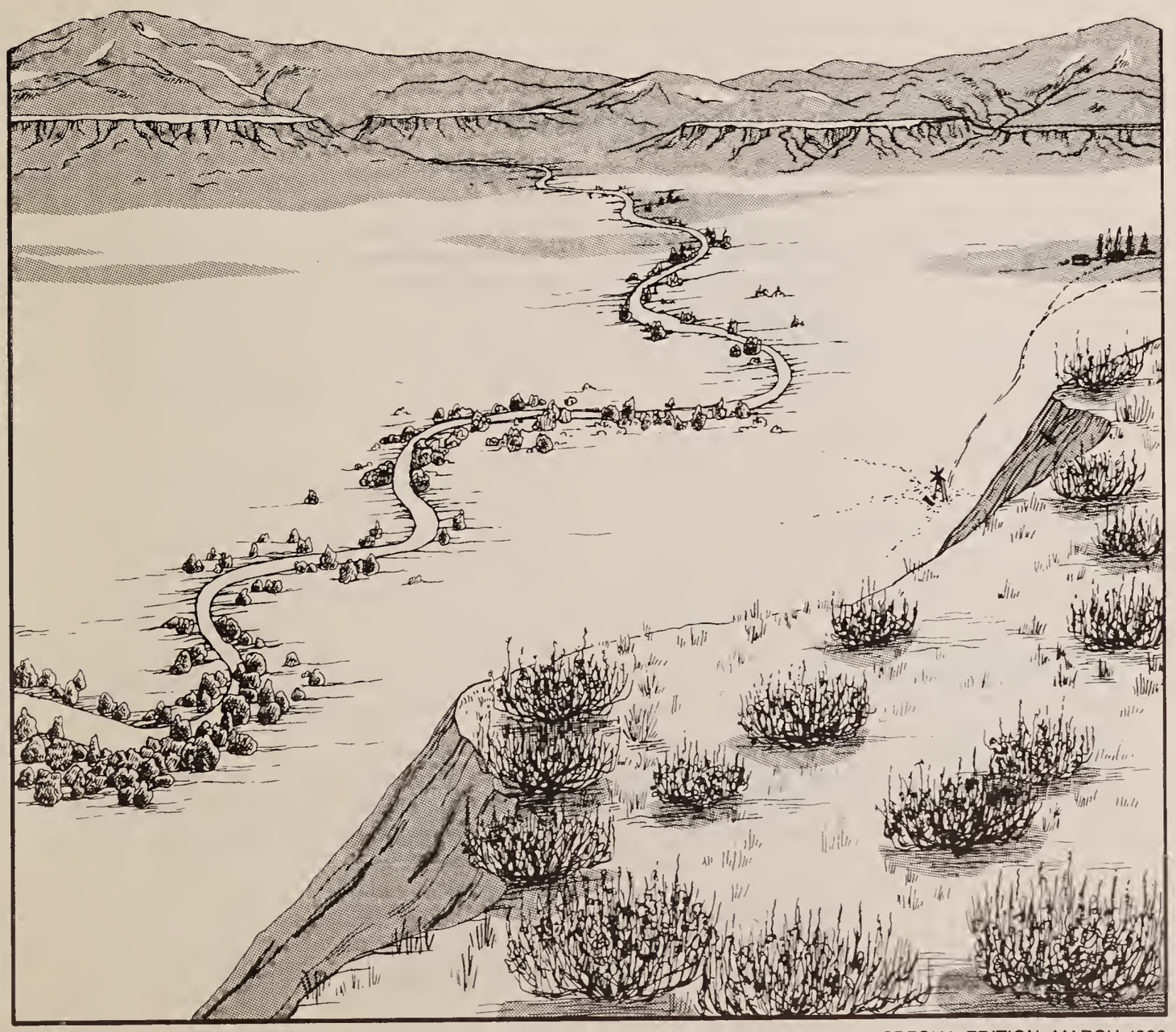
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Edges

Jack Ward Thomas, Chris Maser, and Jon E. Rodiek



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ABSTRACT

Edge can be a measure of overall diversity of any area. Diversity is considered as inherent (community/community) edge, induced (successional stage/successional stage) edge and total edge. Size of stands are related to expected wildlife diversity.
KEYWORDS: Wildlife habitat, range management.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon**. The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of Southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

An edge (fig. 1) is the place where plant communities meet or where structural conditions within plant communities come together. The area influenced by the transition between communities or conditions is called an ecotone (fig. 2). Edges and their ecotones are usually richer in wildlife than are the adjoining plant communities or structural conditions. As a result, they are an important consideration in wildlife management.

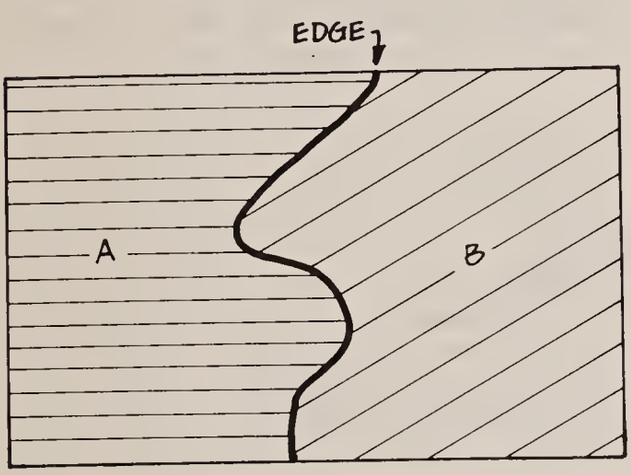
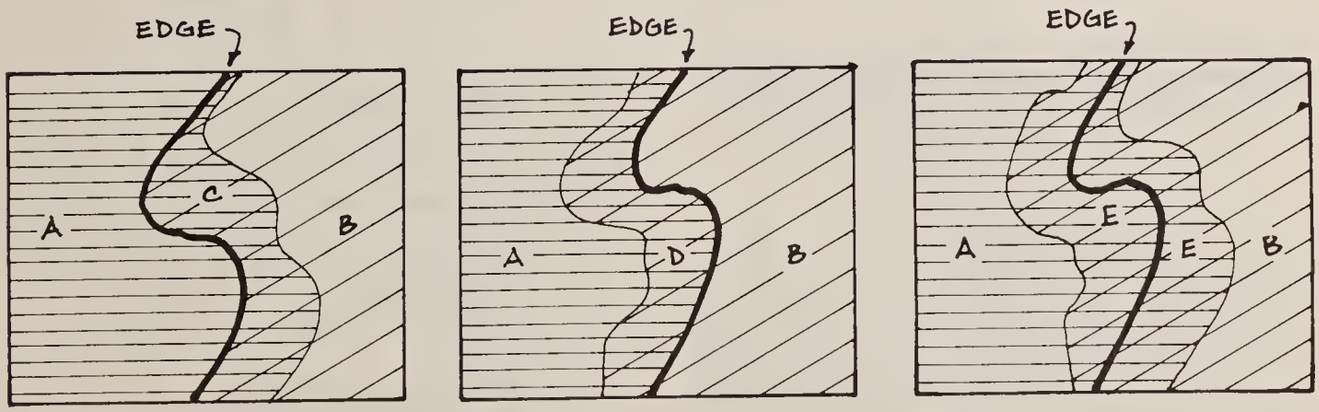


Figure 1.—An edge is the place where plant communities (A and B) or structural conditions within a plant community come together.

Aldo Leopold (1933, p. 132) stated that "game [wildlife] is a phenomenon of edges." Wildlife "occurs where the types of food and cover which it needs comes together, i.e., where these edges meet. . . .We do not understand the reason for all of these edge-effects, but in those cases where we can guess the reason, it usually harks back to the desirability of simultaneous access to more than one environmental type, or the greater richness of border vegetation or both."

As biologists investigated the effects of edge on wildlife, they began to recognize other relationships that helped explain the phenomenon. These concepts have become known as the "laws" of dispersion and interspersion.

Dispersion describes the pattern of distribution of individuals in an animal population. In the mathematical sense, dispersion describes the probability of occurrence of such individuals in particular places (Hanson 1962). The law of dispersion says that the potential density of wildlife species with small home ranges that require two or more types of habitat is roughly proportional to the sum of the peripheries of those types (Leopold 1933, Dice 1931). This means that species which are adapted to particular edges and their ecotones increase in proportion to an increase in edges of the appropriate kind.



Some influence of community A extends into B along the edge forming ecotone C.

Some influence of community B extends into A along the edge forming ecotone D.

When influence of community A extends into B and that of B into A, ecotone E is formed.

Figure 2.—Ecotones are formed along edges and may be created in several ways.

The law of dispersion was developed from studies of small animals with small home ranges. Later research indicates that some larger mammals with wider home ranges also use edges and ecotones disproportionately more than other habitats. This is particularly true where the edge occurs between relatively open areas and cover areas (Harper 1969, Reynolds 1962 and 1966).

Interspersion is the intermixing of plant species and plant communities that provides habitat for animals within a defined area (Hanson 1962). The law of interspersion says that the number of resident species requiring two or more types of habitat depends on the degree of interspersion of numerous blocks of such types (Kelker 1964).

The laws of dispersion and interspersion work together to show the range manager how to increase wildlife populations associated with edge. More edge of a particular type will produce more individuals of the wildlife species associated with that edge. Edge effect can be magnified by increasing the interspersion of the types of habitat creating those edges. Wildlife managers, then, have two factors to consider in evaluating the role of edge—the amount of edge and how it is arranged.

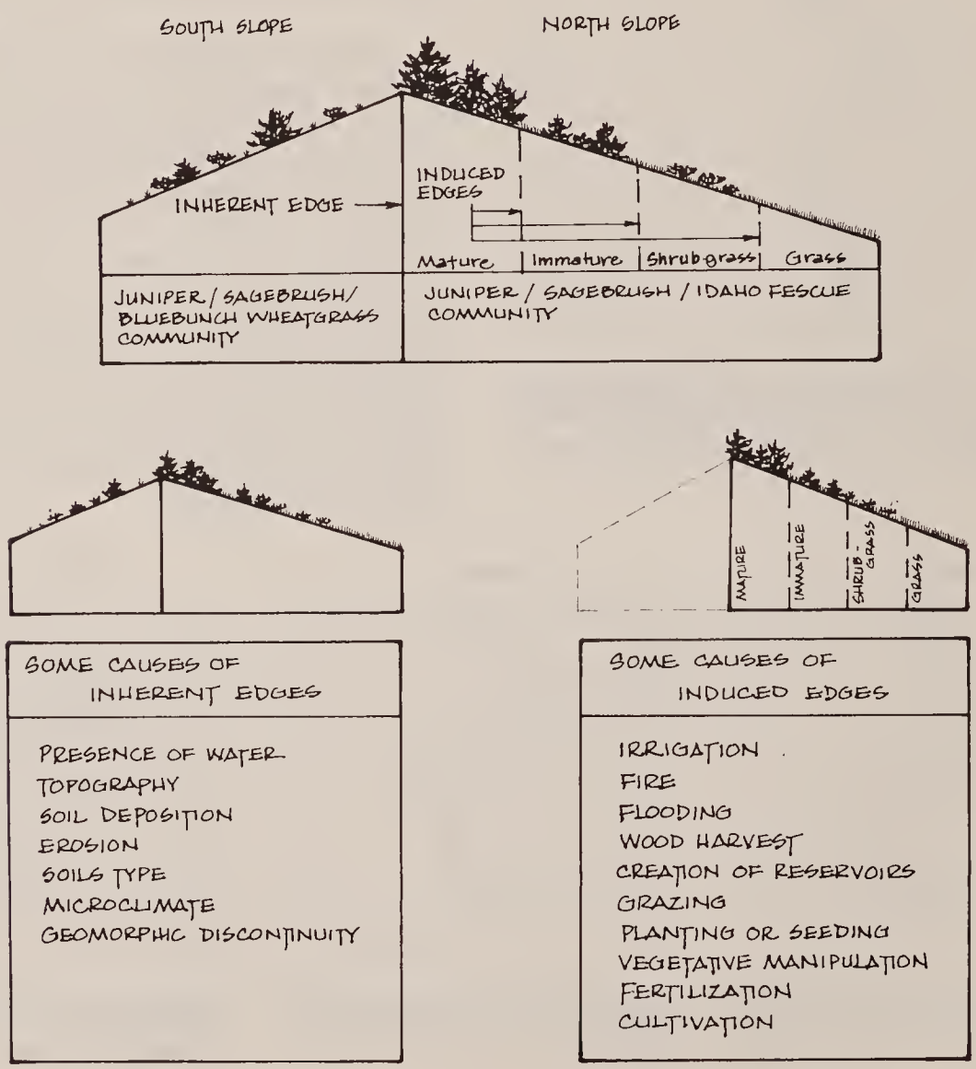


Figure 3.—Inherent edges are created where plant communities meet. Induced edges are created where structural conditions within communities come together. Inherent and induced edges are created by many factors.

Inherent Edge

An edge that results from the meeting of two plant communities is called an inherent edge (fig. 3). The plant community is the tangible expression or integrator of the myriad influences acting on a particular site (Daubenmire 1976). The edges between plant communities, as far as the land manager is concerned, are issued with the area—that is, they are inherent. Four of the most obvious natural factors that work separately and in combination to produce inherent edges are: (1) abrupt changes in soil type, (2) topographic differences, (3) geomorphic differences, and (4) changes in microclimate.

Inherent edges are long-term features of the landscape; they result from geomorphic conditions or other factors that create the plant communities involved. For all practical purposes, inherent edges are relatively stable and permanent features of the landscape. They can, however, change. For example, subtle modifications in microclimate and soils over many decades may result in a shifting of the plant communities along the edge until it becomes less abrupt. Sometimes the plant communities are broken into patterns of islands and peninsulas until a mosaic pattern emerges (fig. 4). In other situations, a broadened ecotone may result. An inherent edge can also be created suddenly, for example, by severe sheet erosion.

The conditions of the plant communities that form an inherent edge may be altered by management activities or other short-term phenomena. But since the underlying causes for that edge are related to geomorphic factors, inherent edges are very stable and tend, over time, to return to their earlier vegetative state.

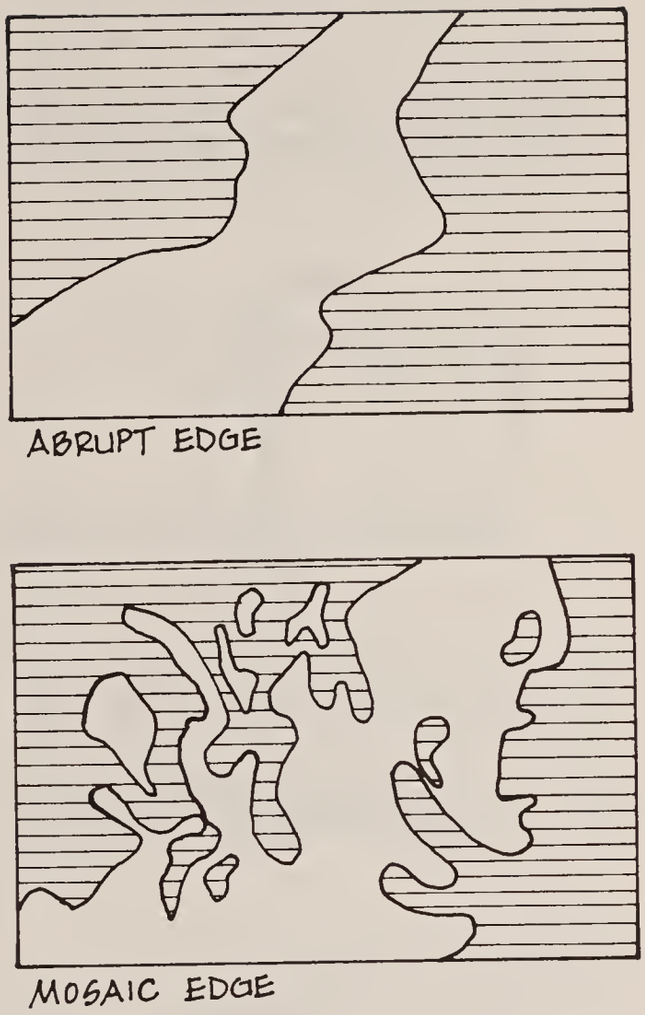


Figure 4.—Inherent edges may be abrupt or mosaic. Inherent edges sometimes evolve into mosaic edges over prolonged periods.

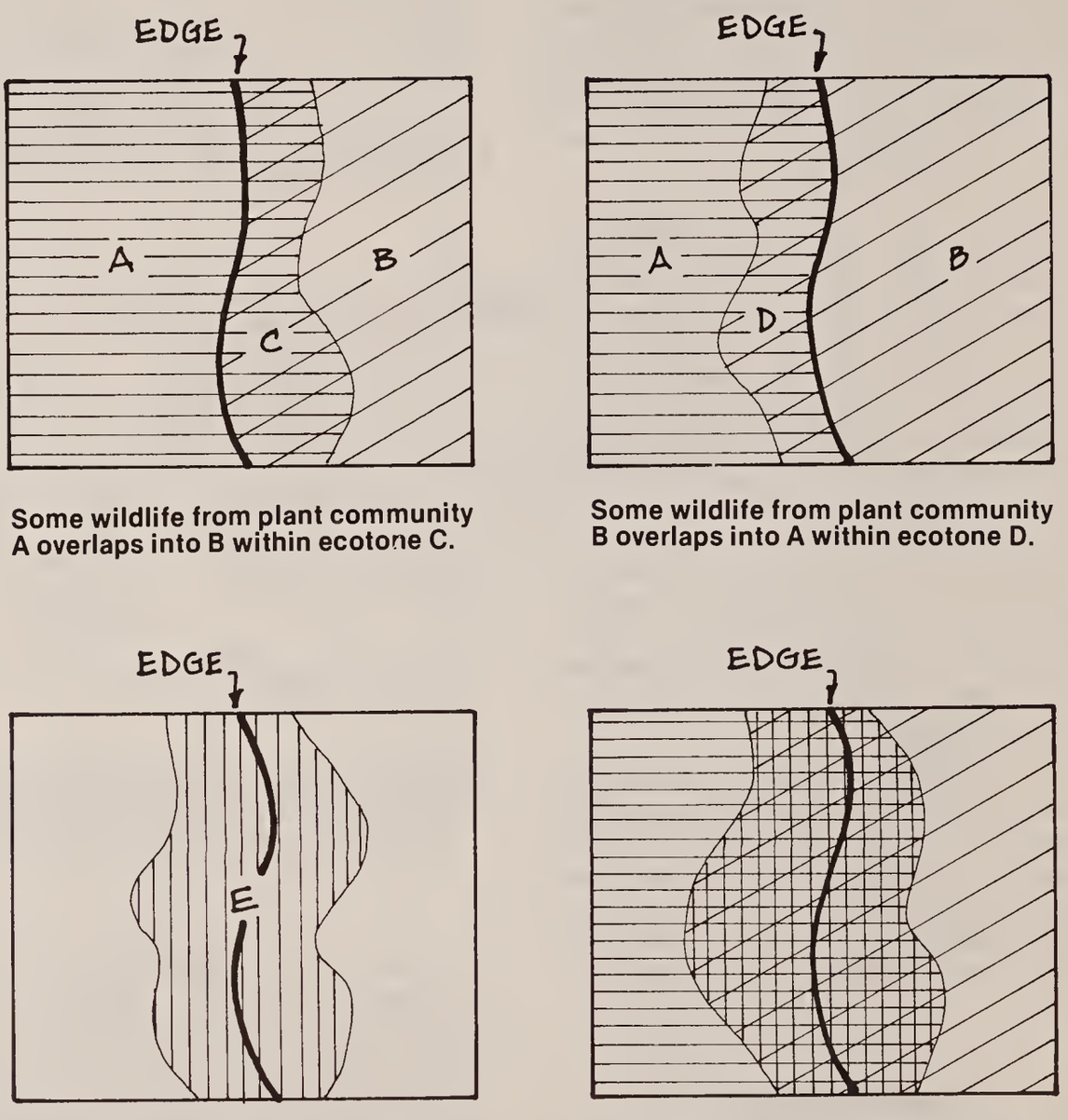
Induced Edges

An edge that results from the meeting of structural conditions within a plant community is called an induced edge (fig. 3). Such edges can be created by management practices or short-term natural phenomenon—that is, they can be induced.

Under natural conditions, induced edges are created by drastic short-term environmental factors, such as fire, disease, insect outbreaks, floods, logging, and erosion (fig. 3). These factors tend to shift plant communities toward earlier, less mature, structural conditions. Compared with inherent edges, induced edges are relatively short lived. Although they may last for many years, they are constantly changing through such things as plant succession and are not permanent features of the landscape.

Importance to Wildlife Management

The biological importance of edges to wildlife managers is expressed by the term "richness." Edges and their ecotones are rich in wildlife, both in number of species and of individuals, because of the additive effect on the flora and fauna when two plant communities or structural conditions come together. In the ecotone there is a mingling of the species common to each type and the addition of other species that may be products of the ecotone itself (Southwood 1972) (fig. 5). In another sense, wildlife richness is related to the plant and habitat diversity expressed in the ecotone.



Some wildlife from plant community A overlaps into B within ecotone C.

Some wildlife from plant community B overlaps into A within ecotone D.

Some wildlife is particularly adapted to ecotone E.

The total wildlife use in the ecotone indicates the habitat and species richness associated with edges.

Figure 5.—Species richness associated with edges is an additive effect.

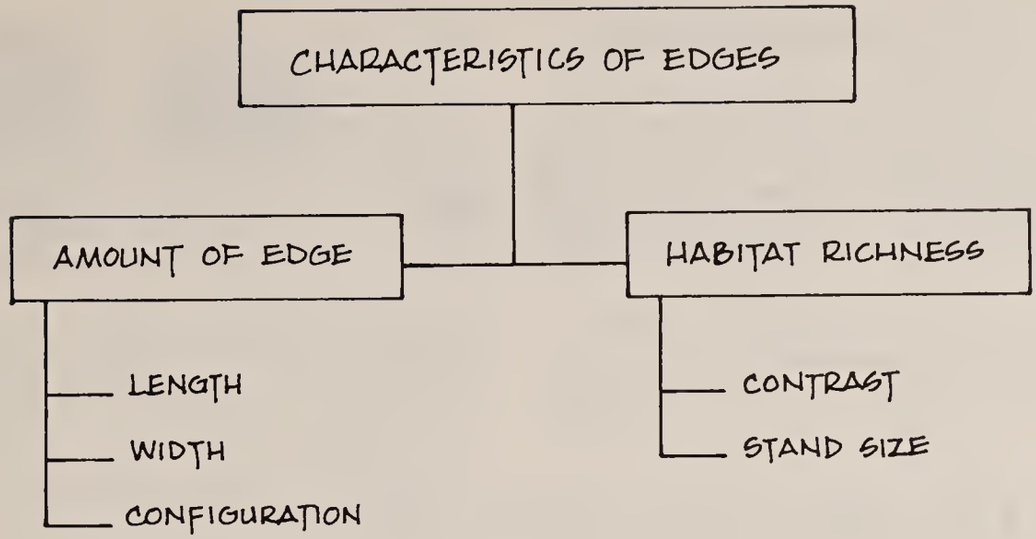


Figure 6.—Edges have characteristics that influence habitat and species richness.

Characteristics of Edges

Edges have characteristics (fig. 6) that influence the amount of edge habitat and the degree of habitat richness. In combination, these two factors determine the total impact of edges as wildlife habitat.

The amount of edge habitat or ecotone in an area is a function of edge width, the length of the edge, and its configuration. The width and length measurements can be used to determine the area of ecotone. An abrupt narrow edge yields less ecotone habitat than a wider edge. Configuration is the arrangement of edges in a pattern that may range from simple to mosaic (fig. 4).

The degree of habitat richness associated with a particular edge is influenced by the size of the plant community and the type of habitat coming together in the edge (Halligan 1974, Johnsgard and Rickard 1957, Wiens 1973). The size of the habitat block has a direct effect on the number of wildlife species in that area (Galli et al. 1976). The species associated with each habitat have a tendency to lap over the edge into the other habitat. So, the larger the habitat blocks, the more species will be associated with them—and the richer the species diversity along the edge.

In addition, habitat richness is associated with the degree of contrast in vegetative structure along the edge. The greater the contrast, the more likely the adjoining habitats are to be very different in structure and in the wildlife species they support. This tends to increase the species richness of the ecotone.

As an example of the effect of contrast, consider the idealized structural conditions in figure 7. There are 5 structural conditions that can be formed into 10 combinations by the joining of 2 conditions. Each combination produces a different degree of contrast. Little contrast is produced by combining closely related conditions. Contrast can be dramatic, however, if an early structural condition is joined with a late condition. The degree of contrast may be determined by subtracting the smaller identifying numbers from the latter. The greater the difference, the greater the contrast.

Area Size and Diversity

At some point, increasing diversity tends toward homogeneity and tends to become decreasingly diverse. Galli et al. (1976, p. 356) said that "The number of species present in a particular habitat is strongly influenced by the size of that habitat." The number of species of

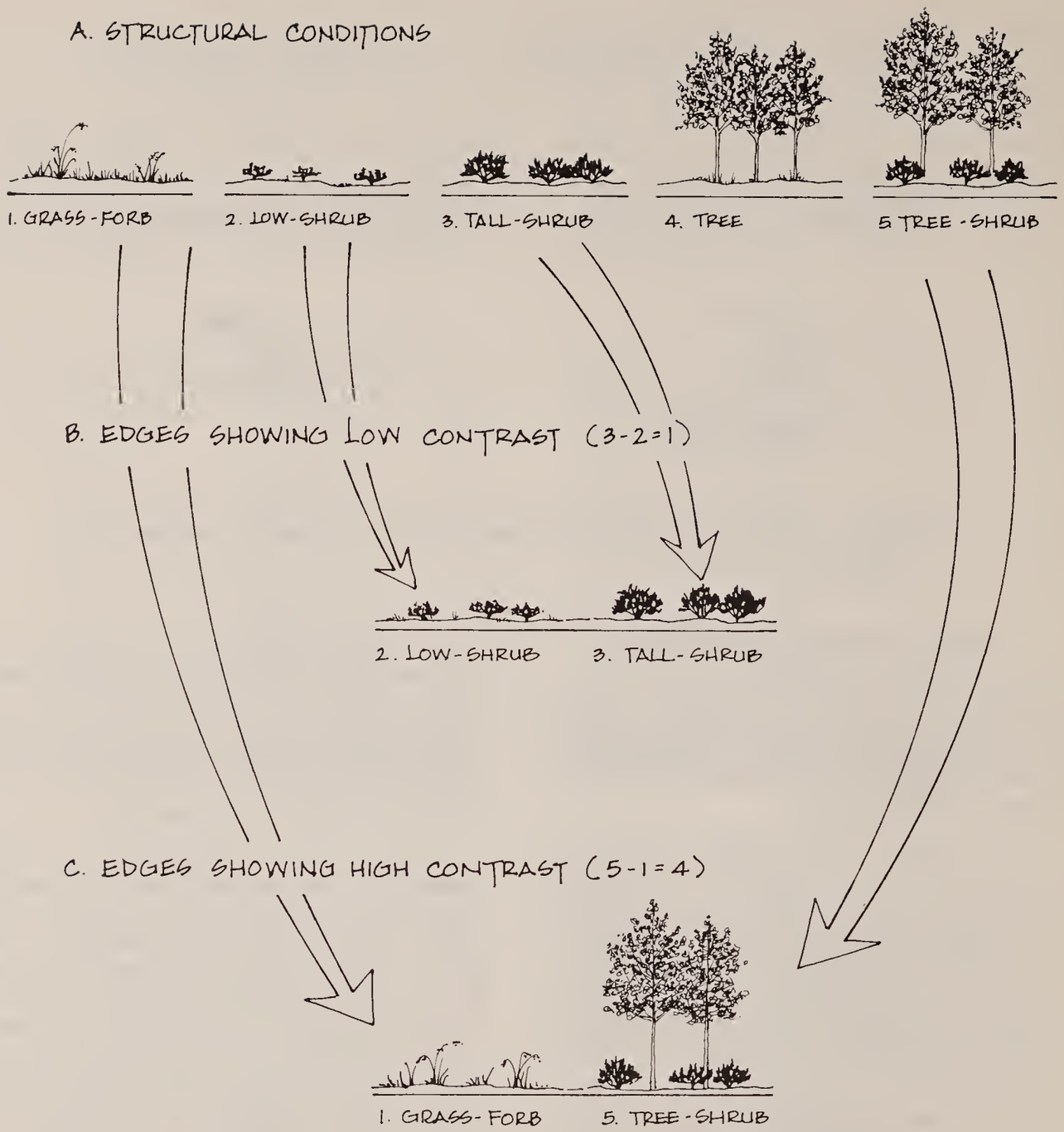


Figure 7.—Different combinations of edges yield different degrees of contrast in structure.

both animals and plants in an area is another indicator of diversity. Arrenhius (1921) and Gleason (1922) seem to have pioneered this concept. The rather voluminous literature on the subject that has developed since that time is well summarized and reviewed by Cain and Castro (1959) and Greig-Smith (1964).

Hopkins (1955), Preston (1960), and MacArthur and Wilson (1967) discuss "species-area curves" or the relationship of numbers of plant and animal species to increasing size of an area in a particular ecological condition. After review of this literature and experimental examination of the relationship

of habitat size to species diversity of birds, Galli et al. (1976) concluded that there was usually a direct linear relationship between the number of species and the logarithm of the area, and that there were distinct relationships for different areas. This simply means that the number of species occupying an area usually increases with the size of the area.

Increasing wildlife diversity tends to become decreasingly diverse when the average size of the habitat blocks becomes smaller than that required to maximize the number of species present (fig. 8). Since no data could be found for rangeland ecosystems, the information of Galli et al. (1976) is used to illustrate the point. Galli et al. studied the relationship between the number of bird species present and the size of blocks of forest habitat interspersed with agricultural lands in New Jersey. They found (p. 363) that "Bird species richness increases significantly through an island size of 24 hectares (59.30 acres) and is likely to continue increasing significantly at forest sizes beyond 24 hectares." Increase in bird species with size of habitat was attributed to: (1) the addition of new species as their minimum habitat size requirements were met, (2) the inclusion of specific habitat components in sufficient quantity, and (3) the presence of specialized conditions in the interior of the forest stands.

Study of a 44-hectare (108.72-acre) plot showed a decline of species numbers over the numbers predicted by the "best-prediction" equation:

$$y = 0.81 + 4.54\,x^{0.05}$$

where y is species richness and x is forest area in hectares. The correlation coefficient (R) was 0.92, accounting for 85 percent of the variation in species richness (R^2). Furthermore, the number of species was less than that encountered on the next largest plot of 24 hectares (59.30 acres). The decline was attributed to a loss of species adapted to edges.

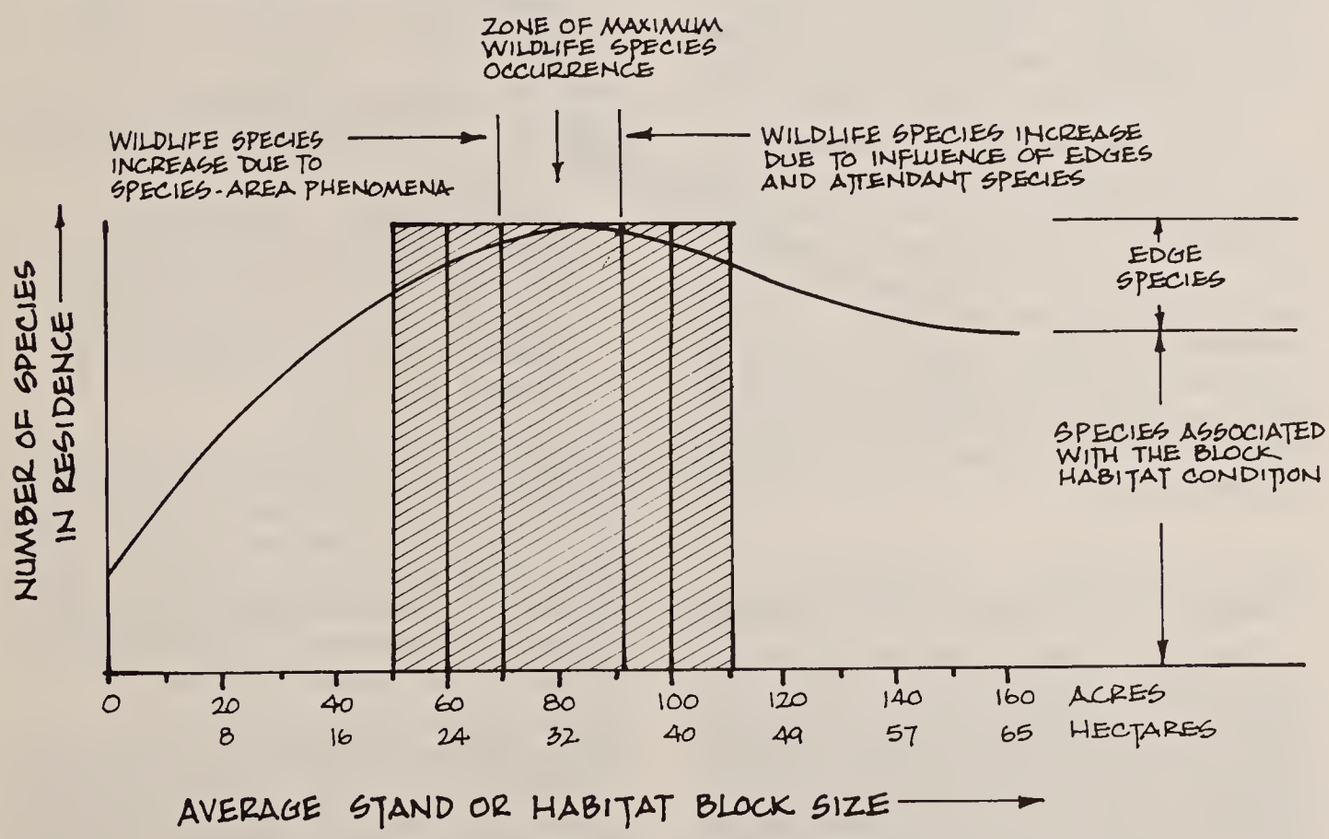


Figure 8.—Wildlife diversity is related to the average size of habitat blocks. The curve is generalized.

Data are lacking for these relationships in southeastern Oregon,but a best estimate is required. Due to the comparative lack of vertical habitat stratification in rangelands as compared to forests, it is obvious that rangeland habitats are not as diverse, and in turn not as rich, as the forest habitats explored by Galli et al. (1976). It seems likely that the increase in habitat size and species occurrence will peak at a higher figure than in forest habitats. Until research data is available, it is suggested that managers assume that wildlife species richness (at least that for birds) will increase significantly with habitat size to about 81 hectares (200 acres) and that bird species richness is a reasonable indicator of the relationship of all vertebrate wildlife to habitat size.

So, wildlife species richness should be approaching the maximum where the average habitat size is approximately 81 hectares (200 acres). Pay special attention to the emphasis on "average." This indicates the existence of habitats both larger and smaller than 81 hectares (200 acres). The larger habitats will accommodate those relatively few species that require habitat blocks larger than the average while smaller habitats will increase edge effect.

Some species may require extremely large areas of contiguous and similar habitats. These would suffer if smaller areas were substituted. The requirement of some species for habitat blocks of specific size should not be confused with the animal's need for solitude or protection from the intrusions of man. In some cases, regulation of man's activities may suffice in lieu of preservation of large areas of pristine habitat. This must be determined on a species-by-species basis.

Edge as a Measure of Diversity

Emphasis on management for diversity in rangeland ecosystems will help to insure the continued existence of the living components of that system—plants as well as animals. That goal is laudable for esthetic or moral reasons alone, but it is also a practical management objective. In the ecological sense, diversity is thought to be related to stability or the ability of a system, when changed from a steady state, to develop forces that tend to restore its original condition (Margalef 1969). Diversity acts as insurance for the system by increasing its ability to withstand disaster.

It has been said that the first rule of intelligent tinkering is to save all the pieces (Leopold 1949). A concern for diversity is a step toward insuring the continued existence of all the pieces in managed rangeland ecosystems.

Some land management agencies are beginning to be concerned about diversity. For example, the United States Department of the Interior, Bureau of Land Management Manual 1603—Supplemental Guidance (1973, p. 12D), under "Long-Term Objectives," directs that BLM will:

> a. Maintain a maximum diversity of wildlife species in sufficient numbers to meet public demands. This will be accomplished by means of habitat management.

And under "Major Principles and Standards" (1973, p. 12D), Manual 1603 further states that:

> c. The essential requirements of wildlife—food, cover, and water—will be maintained so as to provide optimum 'edge effect' and interspersion of habitat components in important wildlife areas.

The Chief of the USDA Forest Service has stated that the wildlife goal for the National Forest System is to insure wildlife diversity and to maintain or enhance wildlife populations (USDA Forest Service 1976). If diversity is a goal in rangeland management, it behooves managers and planners to be able to measure it and account for it in their activities.

Both inherent and induced edges are a direct reflection of the total diversity (fig. 9) in an area. Patton (1975) indicated that edge can be used as a measure of diversity. Traditional diversity indexes (Pielou 1975) require information about numbers of plant and animal

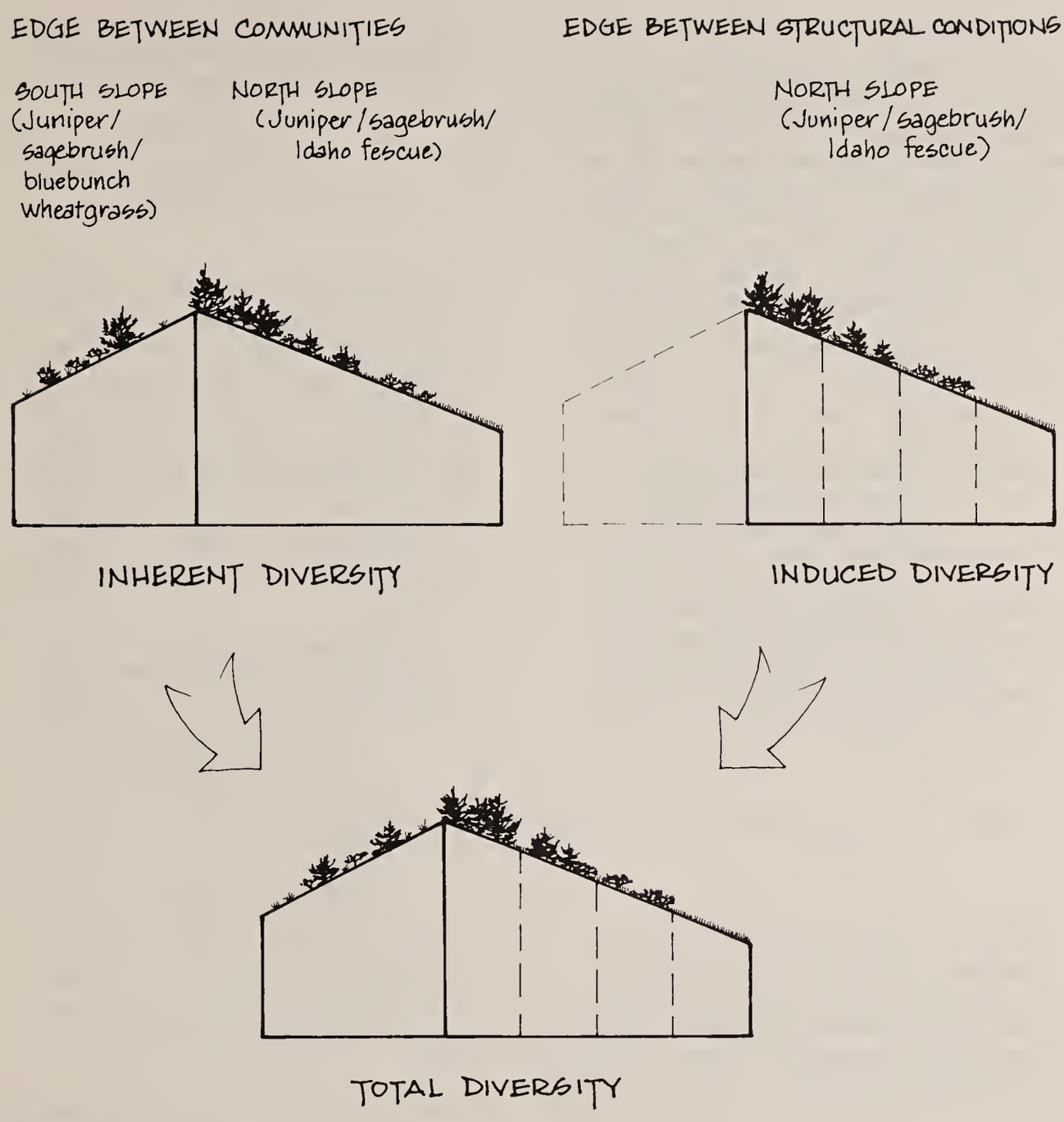


Figure 9.—The type, amount, and arrangement of edges is an expression of habitat diversity.

species and their frequency of occurrence. This approach is too expensive for planners and managers who must operate under severe constraints of budgets, personnel, and time. A feasible alternative is to use edge as an indicator or index of diversity.

There are at least three uses for a diversity index in rangeland management: (1) to investigate trends in habitat diversity, (2) to evaluate management alternatives for their immediate and long-term effects on diversity, and (3) to evaluate the effect of livestock grazing on diversity.

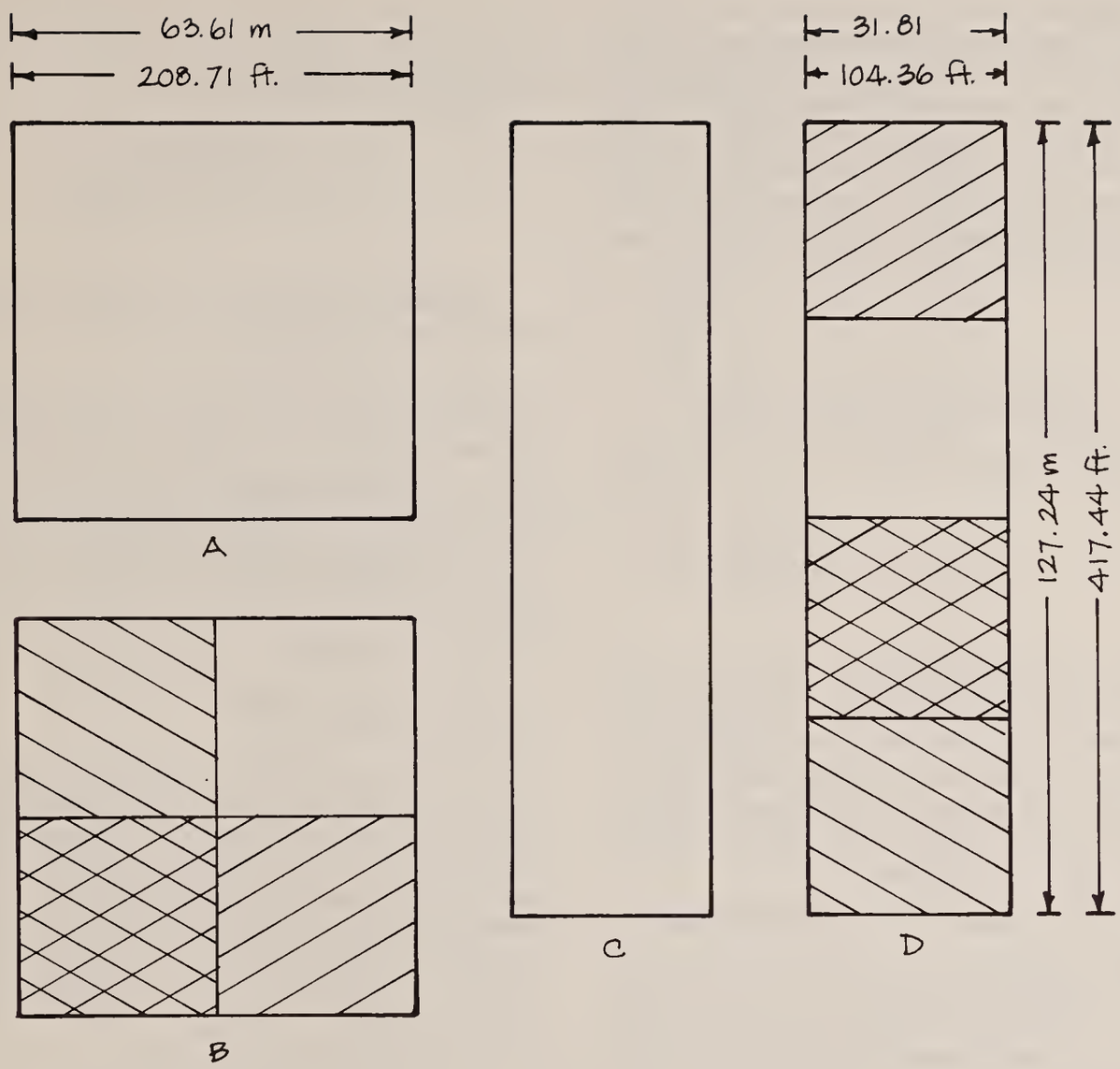
Derivation of Diversity Index

Patton (1975) described a system that expressed, by index, the amount of edge within an area of any given size. Because of the relationship between edge and interspersion and because these factors are a measure of diversity, he referred to this measure as the diversity index. Patton worked entirely with English measurements, but the same results may be achieved with metric measurements.

The following is taken directly from Patton (1975, p. 172). DI signifies the diversity index:

> The geometric figure with the greatest area and least perimeter or edge is a circle. If the ratio of circumference to area of a circle is given an index value of 1, a formula can be derived to compute a comparable index for any area to compare with a circle. Any index larger than 1 is a measure of irregularity and can be used as a DI. A 1-acre circle has a circumference of 739.86 feet and an area of 43,560 square feet. The formula to set the ratio equal to 1 is:
>
> $$\frac{C}{2\sqrt{A \cdot \pi}} = 1$$
>
> where C is the circumference, A is the area, and π is 3.1416. This same formula is often used by limnologists to express shoreline irregularity of a lake. The next step is to restate the formula for habitat diversity as:
>
> $$DI = \frac{TP}{2\sqrt{A \cdot \pi}}$$
>
> where TP is the total perimeter around the area plus any linear edge within the area.
>
> Several examples will show how the DI is computed and what it means. A 1-acre square has 208.71 feet on a side . . .[fig. 10A], and the perimeter of the block is 834.84 linear feet. Substituting these values in the formula:
>
> $$DI = \frac{834.84}{2\sqrt{43{,}560 \times 3.1416}} = 1.13$$
>
> This indicates that a square of 1 acre has 0.13 times more edge than a circle of 1 acre. Dividing the 1-acre block into 4 units of different vegetation types increases the DI to 1.69. . .[fig. 10B]. If the 1-acre block is divided into 4 blocks in a long narrow unit. . .[fig. 10D], then the DI is increased to 1.83. In. . .[fig. 10D] the TP (1,356.68 feet) is computed by adding the outside perimeter (1,043.60 feet) to the 3 inside edges (313.08 feet).
>
> The DI can be expressed as a percentage figure when convenient. It is only necessary to rewrite the formulas as:
>
> $$\text{Percent} = (DI - 1)100$$
>
> For the 1-acre square with a DI of 1.3 the percent is:
>
> $$(1.13 - 1) \times 100 = 13\%$$
>
> This percent figure simply means that the 1-acre square has 13 percent more perimeter than a 1-acre circle. A square-mile block also will have 13 percent more perimeter than a circle of the same area.

Patton's diversity index assumes that the total perimeter of an area is actually edge. In that case, the index is valid. But usually all or part of the perimeter of an area under consideration is not an edge in the ecological sense. In such cases, the index will not be valid. Furthermore, if diversity is expressed as a product of edge, it seems best to consider it as derived from two sources: (1) inherent edge, and (2) induced edge (see fig. 9). As a result, Patton's index has been modified in the following discussion to make it more applicable in land-use planning and land management.



CONFIGURATIONS OF 1-ACRE AREA	TOTAL EDGE		DIVERSITY INDEX
	METERS	FEET	
A	254.46 m	834.84 ft	1.13
B	381.69 m	1,252.26 ft	1.69
C	318.09 m	1,043.60 ft	1.41
D	413.52 m	1,356.68 ft	1.83

Figure 10.—Comparison of diversity indexes for four 1-acre configurations. Feet converted to meters by multiplying by factor 0.3048 (adapted from Patton 1975).

Inherent edges are site-related and are created when plant communities meet. Such edges may be considered as the degree of diversity "given" to the area. Induced edges occur when structural conditions within plant communities come together. Induced edges can be produced when and where desired by the rangeland manager and are certain to result from any activity that alters vegetative structure.

Inherent Diversity Index

The inherent diversity index is computed as follows:

$$\text{Inherent DI} = \frac{TE_c}{2\sqrt{A \cdot \pi}};$$

where TE_c is the total edge between plant communities in feet or meters found within or on the perimeter of the area under consideration, A is the area expressed in square feet or square meters, and π is 3.1416. The inherent DI is expressed as a percentage increase over perfect simplicity by this process:

Inherent DI, percent = (Inherent DI)100

Perfect simplicity may be expressed as DI = 0. Perfect simplicity may also be viewed as any delineated area which has no edge present—either internally or on the periphery.

In figure 11, a 60.9- × 60.9-meter square of 3 708.8 m^2 (200- × 200-foot square of 40,000 ft^2) is divided into four equal plant communities. In this case, the perimeter of the area is also inherent edge. The inherent DI in percent is computed as follows:

$$\text{Inherent DI (in feet)} = \frac{TE_c}{2\sqrt{A \cdot \pi}} = \frac{1{,}200 \text{ ft}}{2\sqrt{(40{,}000 \text{ ft}^2)(3.1416)}} = 1.69.$$

$$\text{Inherent DI (in meters)} = \frac{TE_c}{2\sqrt{A \cdot \pi}} = \frac{365.8 \text{ m}}{2\sqrt{(3\ 708 \text{ m}^2)(3.1416)}} = 1.69.$$

Inherent DI in percent = (inherent DI)100 = (1.69)100 = 169%.

The number of plant communities represented is also an important component of inherent diversity. Although the number of plant communities will obviously increase the inherent DI in percent, an added descriptor showing the number of communities seems appropriate (Patton 1975). The descriptor may be added in parentheses after the inherent DI in percent. In this case:

Inherent DI in percent (number of communities) 169%(4).

In this example the total perimeter represents inherent edge and was included in calculating TE_c. If all or part of the perimeter had not been inherent edge, those parts would not have been used in computing TE_c. In other words, only the portions of the perimeter that are inherent edge are used in deriving TE_c. This is a modification of the approach described earlier (Patton 1975).

Induced Diversity Index

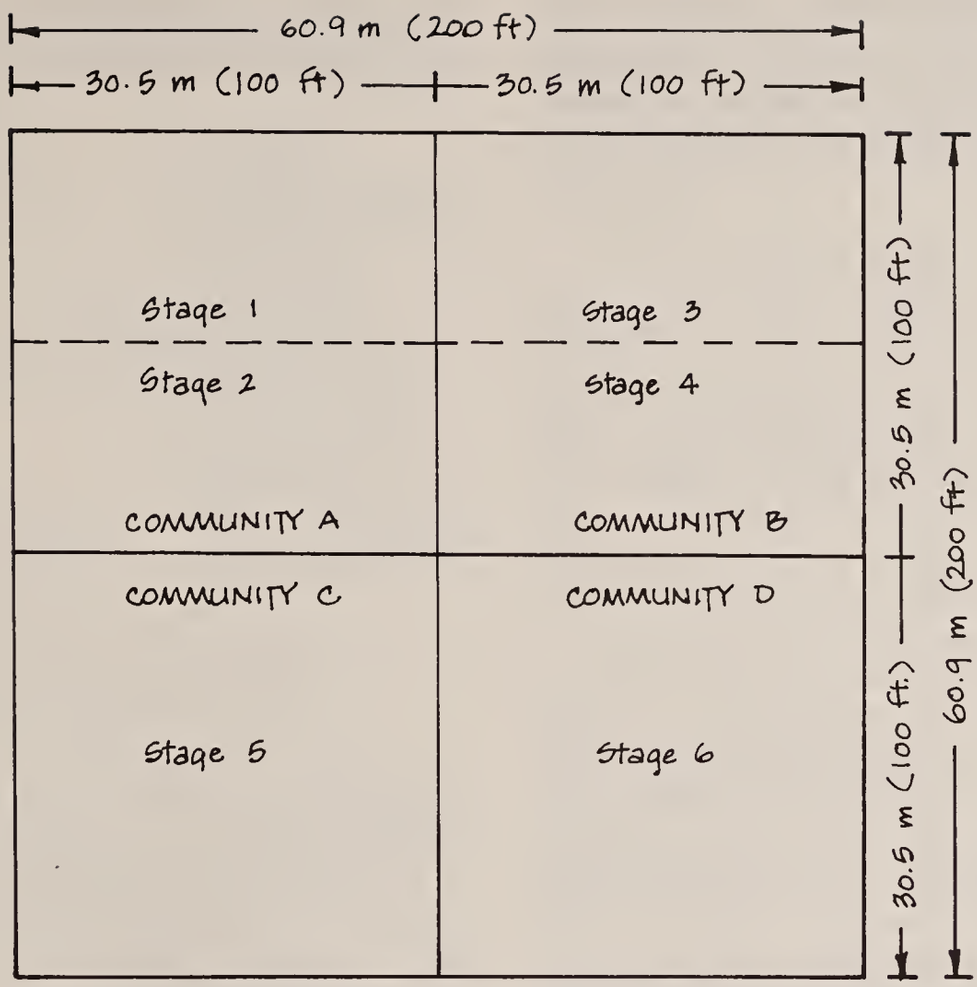
Induced diversity can be expressed in the same manner:

$$\text{Induced DI} = \frac{TE_s}{2\sqrt{A \cdot \pi}}$$

where TE_s is the total length of the edges (in feet or meters) created between structural conditions, within plant communities or along their peripheries, for the area under consideration.

Then,

Induced DI in percent = induced DI(100).



PLANT COMMUNITIES: A, B, C, D
STRUCTURAL CONDITIONS: 1, 2, 3, 4, 5, 6
INHERENT EDGES: ————————
INDUCED EDGES: — — — — — — —
TOTAL AREA IN METERS: (60.9 m) (60.9 m) = 3 708.8 m^2
TOTAL AREA IN FEET: (200 ft) (200 ft) = 40,000 ft

TOTAL INHERENT EDGE:	365.8 m	1,200 ft
TOTAL INDUCED EDGE:	+60.9 m	+ 200 ft
TOTAL EDGE:	426.7 m	1,400 ft

Figure 11.—An area showing plant communities, structural conditions, and edges.

Again consider figure 11. The dotted lines represent induced edge within plant communities A and B. The TE_s is 60.9 meters (200 feet) and the total area is 3 708.8 square meters (40,000 ft^2). The induced DI in percent is computed as follows:

$$\text{Induced DI (in feet)} = \frac{TE_s}{2\sqrt{A \cdot \pi}} = \frac{200 \text{ ft}}{2\sqrt{(40{,}000 \text{ ft}^2)(3.1416)}} = 0.28.$$

$$\text{Induced DI (in meters)} = \frac{TE_s}{2\sqrt{A \cdot \pi}} = \frac{60.9 \text{ m}}{2\sqrt{(3708.8 \text{ m}^2)(3.1416)}} = 0.28.$$

Induced DI in percent = induced DI(100) = 0.28(100) = 28%.

The number of structural conditions represented should be added in parentheses after the induced DI in percent as a further descriptor of induced diversity:

Induced DI in percent (number of structural conditions) 28%(6)

Total Diversity Index

Total DI is an index of the combined effects of inherent DI and induced DI. This is computed as follows:

$$\text{Total DI} = \frac{TE_{c+s}}{2\sqrt{A \cdot \pi}}$$

and,

Total DI in percent = (Total DI)100;

where TE_{c+s} is the total length, in meters or feet, of all inherent and induced edges. This is computed as follows (see fig. 11):

$$\text{Total DI (in feet)} = \frac{TE_{c+s}}{2\sqrt{A \cdot \pi}} = \frac{1{,}400 \text{ ft}}{2\sqrt{(40{,}000 \text{ ft}^2)(3.1416)}} = 1.97.$$

$$\text{Total DI (in meters)} = \frac{TE_{c+s}}{2\sqrt{A \cdot \pi}} = \frac{426.7 \text{ m}}{2\sqrt{(3708.8 \text{ m}^2)(3.1416)}} = 1.97.$$

Total DI in percent = total DI(100) = 1.97(100) = 197%.

Total DI in percent can be enhanced by showing the contributions of the number of plant communities and the number of structural conditions as follows:

Total DI in percent (number of communities) (number of structural conditions) = 197%(4)(6).

Note that when the expressions of inherent and induced diversity are added they equal total diversity:

	Inherent DI in percent	169
+	Induced DI in percent	+ 28
	Total DI in percent	197

Therefore, if any two of the indexes are known, the third may be derived by appropriate addition or subtraction.

Mapping Codes

The indexes just discussed can be helpful in evaluating the general status of edges and diversity in a planning area. The rangeland

manager may find it desirable to account for the amount and characteristics of individual edges in an area. The following coding system is suggested:

Edge type:	T = induced; P = inherent
Community:	Community-community for inherent edges; Community for induced edges. The code is the first two letters of the genus and species names.
Length:	In feet or meters
Average width of the ecotone:	In feet or meters
Contrast:	1 to 4
Configuration:	A = abrupt; M = mosaic

Example: T - *AR TR* - 1,700 - 25 - 4 - A

The codes in this example mean that the area has an edge that is inherent; it is within the *Artemisia tridentata* community; it is 1,700 feet long and 25 feet wide; the contrast is 4; and it has an abrupt edge (A).

Management Tips

Each range area has a unique set of possibilities for diversity. One area may have a high degree of diversity as a result of its inherent mixture of communities. Conversely, an area may have only one or a few communities all in the same structural condition and may be a good candidate for improvement in diversity if that is in keeping with management objectives.

The diversity of an area cannot be increased indefinitely by making more and smaller "islands" and more edges. Beyond some point, the area's increasing heterogeneity tends toward homogeneity (fig. 9). The pieces become so small and mixed that they assume a sameness.

Diversity as a concept and goal of wildlife habitat management has become a shibboleth for many land-use planners and range managers. This is because diversity seems to be a worthy goal. First, a wide variety of habitats are maintained which assures the presence of many kinds of wildlife. Second, all pieces of the system are preserved. Third, the system is protected to some extent from potential disasters.

As a result, the use of diversity as a goal has a certain biopolitical appeal. Very broad diversity goals, loosely stated, can be used to justify management activities and make accountability unlikely. In this context, diversity goals are essentially nonconstraining. The range manager can give a good story about wildlife habitat management, never state the objectives precisely, and never have to show exactly how the goal of diversity was accomplished. This is a misuse of the concept.

Diversity as a goal in management must be used with caution. The degree of habitat diversity can be "good" or "bad" only in relation to management goals and objectives. And maximum diversity may not always be an appropriate choice. For example, it is impossible to maximize diversity and at the same time maximize numbers of a particular species. Thus, diversity is a measure of habitat condition and must be considered in combination with the needs of the affected species. A mix of management for species richness and featured species management is feasible and will probably preclude the loss of any species while insuring desired yields of the featured species—usually game or threatened or endangered species (Gill et al. 1976).

Diversity is meaningful only in the context of clearly stated range management objectives. If diversity is a goal of land management, it can be accomplished only if the manager is willing and able to measure changes in diversity. Without a concise statement of goals and adequate measurement of the status of diversity, range managers cannot be held accountable.

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Geomorphic Habitats

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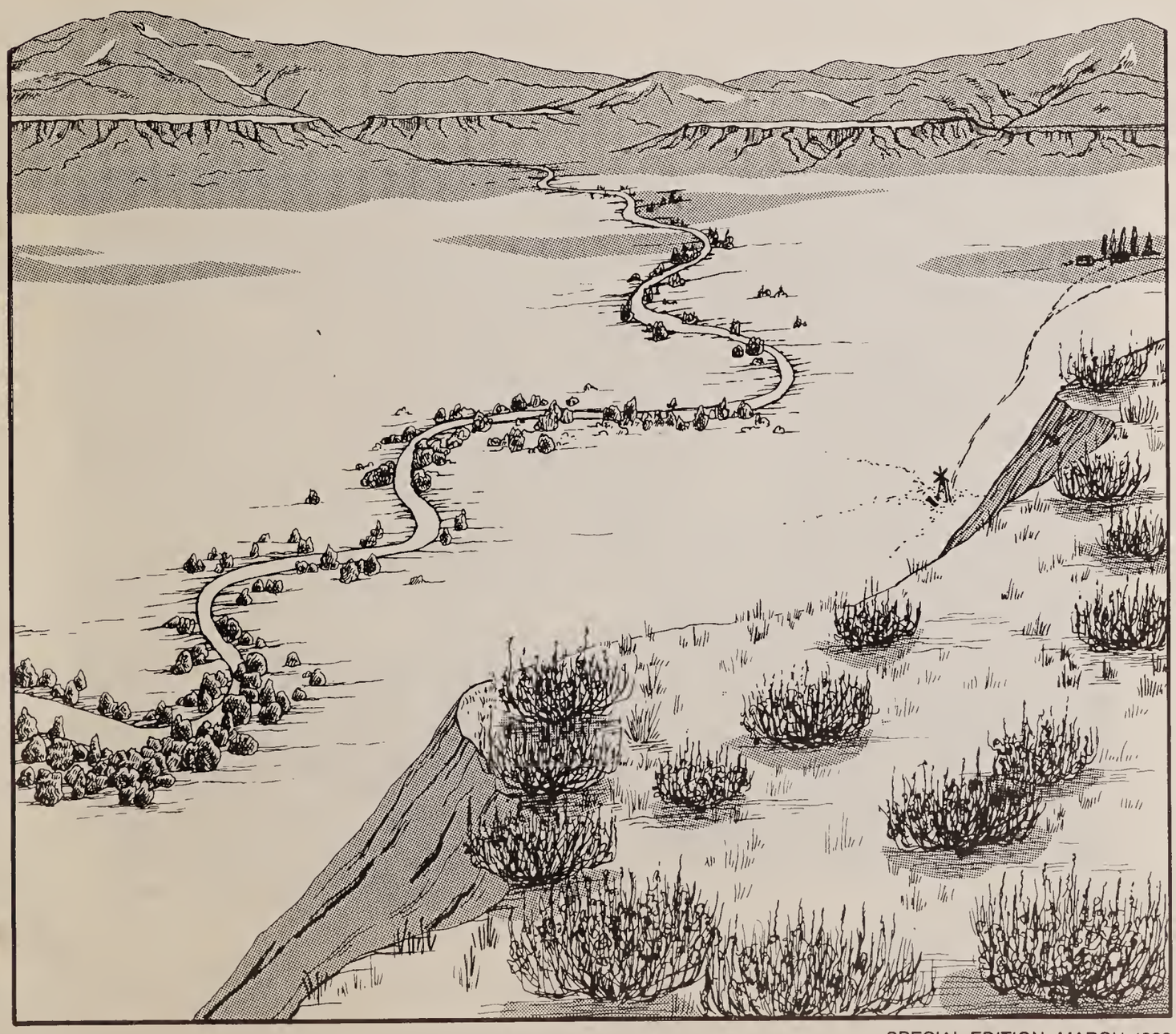
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Geomorphic and Edaphic Habitats

Chris Maser, J. Michael Geist, Diane M. Concannon,
Ralph Anderson, and Burrell Lovell



SPECIAL EDITION, MARCH 1986

ABSTRACT

Geomorphic and edaphic habitats in rangelands provide specialized habitats for some species of vertebrate wildlife. These habitats and how they function as specialized habitat features are examined. The relationships of the wildlife of the Great Basin to such features are detailed.
KEYWORDS: Wildlife habitat, geomorphology, edaphic relations, range management, Oregon (Great Basin).

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This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon.** The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of Southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

The Great Basin of southeastern Oregon is predominantly gentle in topography and monotonous in appearance. To many people, the region is bleak and desolate. It is a land of almost constant wind, of hot summers and cold winters, of dramatic contrasts in climate and in topography.

Physiographic features, such as cliffs (fig. 1), caves, and sand dunes, provide diversity in an otherwise homogeneous landscape; this diversity attracts people for a variety of reasons.

People rafting down the Owyhee River, for example, may be awed by the stark, silent beauty of the massive surrounding cliffs. But they may look at the cliffs without appreciation of what they represent, for they are unaware of the myriad of habitats that a cliff provides for vertebrate wildlife. Although they may see a prairie falcon land on a rock pinnacle, they do not see the white-throated swift nest under a loose, vertical slab of rock high on the cliff face and are unaware of the western pipistrelle, the canyon mouse, or the bushy-tailed woodrat deep in the crevices.[1]

They may not know that, without the cliffs, many species of wildlife would no longer inhabit the area. And they are perhaps not consciously aware that their primary attraction to the area was the beauty, contrast, and uniqueness of the cliffs.

[1]For scientific names of wildlife, see appendix 2.

Figure 1.—Cliffs, rising abruptly out of a relatively gentle landscape, concentrate a diverse fauna. People are attracted to such features by their beauty and by the wildlife that inhabit them. Other attractions include human artifacts and mineral deposits (photo courtesy Bureau of Land Management).

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With a broad awareness and understanding of particular physiographic features, one begins to appreciate them as wildlife habitat, their relationship to land management, and the need to account for them in land use planning. Our purpose is to describe such physiographic features of the Great Basin and to examine them as habitats for wildlife.

Physiographic features are either geomorphic or edaphic. Geomorphic features are products of geologic or geomorphic processes and include cliffs, caves, talus, lava flows, sand dunes, and playas. Edaphic features are local, distinctive soils that, along with their vegetation, contrast markedly with the surrounding area.

There are two appendixes. Appendix 1 is a synopsis of physiographic features that displays how each species of vertebrate wildlife uses those features. In addition, species specifically adapted to particular features for part or all of their habitat requirements are identified. Appendix 2 is a phylogenetic list of the vertebrate species by common name and scientific binomial; it lists the references we used in preparing appendix 1.

Cliffs

Cliffs are steep, vertical, or overhanging rock faces that create abrupt changes in the land surface and form distinctive landscape features. Cliffs are composed of rock materials that are divided into two groups on the basis of their resistance to weathering (table 1). A cliff that is resistant to weathering not only lasts longer but also retains longer the attributes that can be exploited by wildlife. Cliffs are further categorized by height, length, joint spacing (cracks or crevices), joint width (table 2), and shape (fig. 2). Combinations of these features provide habitat attributes that can be exploited by wildlife (appendix 1).

Table 1—General resistance of cliffs to weathering

Parent rock	Group I, more resistant	Group II, less resistant
Basalt	X	
Rhyolite	X	
Andesite	X	
Nonwelded tuff		X
Welded tuff	X	
Sedimentary rock (weakly consolidated)		X

Table 2—Structural characteristics of cliffs that produce habitat attributes that can be exploited by adapted species of wildlife

Structural characteristic	Size
Height class	<3 meters (<10 feet) 3-10 meters (10-33 feet) 10-30 meters (33-100 feet) >30 meters (>100 feet)
Length class	<30 meters (<100 feet) 30-100 meters (100-330 feet) 100-500 meters (330-1,640 feet) 500-1 500 meters (1,640-4,920 feet) >1 500 meters (>4,920 feet)
Joint spacing	<0.3 meter (<1 foot) (called netted jointing—fine network of small cracks) 0.3-1.5 meters (1-5 feet) 1.5-7.5 meters (5-25 feet) 7.5-30 meters (25-100 feet) >30 meters (>100 feet)
Joint width (opening size)	<0.15 meter (<0.5 foot) 0.15-0.30 meter (0.5-1 foot) 0.3-0.6 meter (1-2 feet) 0.6-1.5 meters (2-5 feet) >1.5 meters (>5 feet)

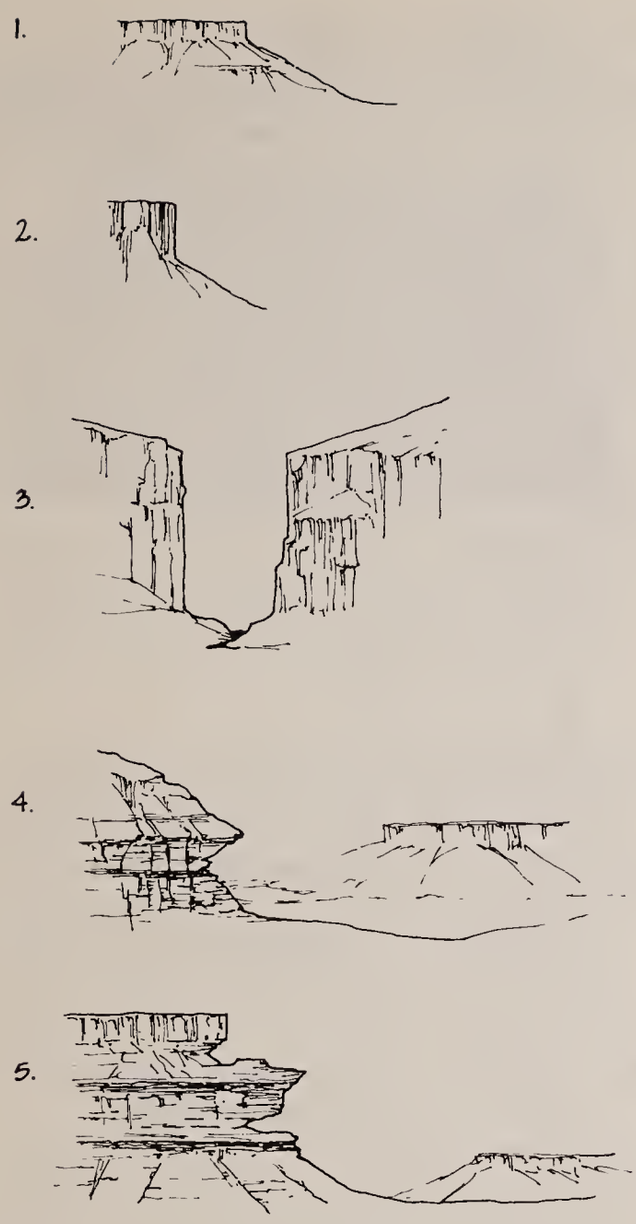


Figure 2.—Shapes of cliffs: (1) cap, (2) scarp, (3) gorge, (4) stratified, (5) combination cap and stratified. (Appendix 1 demonstrates the relationships of wildlife use to these cliff shapes.)

PARENT ROCK

Basalt, andesite, and rhyolite provide the most resistant and prominent cliff features and form shapes 1 through 3 (fig. 2).

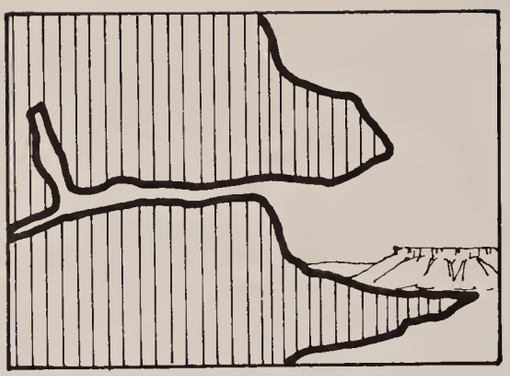
These cliffs have structural attributes, such as jointing, that have importance as wildlife habitat. In southeastern Oregon these features are best developed in basalt. When structural features are considered in combination with the availability of the cliff type, basalt remains the most important material, followed by rhyolite and andesite.

Welded tuff parent materials produce scarp- and gorge-shaped formations (shapes 2 and 3 in fig. 2). Joints in welded tuff are rare, but holes or pockets are common and vary from 0.1 to 1 meter (0.3 to 3.3 ft) in diameter. Such cliffs are frequently angular because of inclusions of rock fragments that are resistant to weathering.

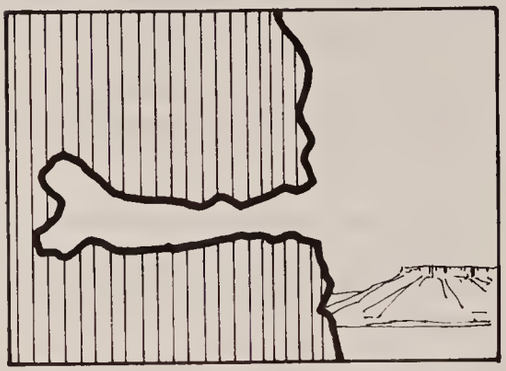
Cliffs composed of sedimentary materials often exhibit banding or layering associated with materials that vary in resistance to weathering, forming shelflike and overhanging features that result in cliff shape 4 in figure 2. Sedimentary formations also occur with caps of basalt or andesite to form cliff shape 5 in figure 2.

IMPORTANCE TO WILDLIFE

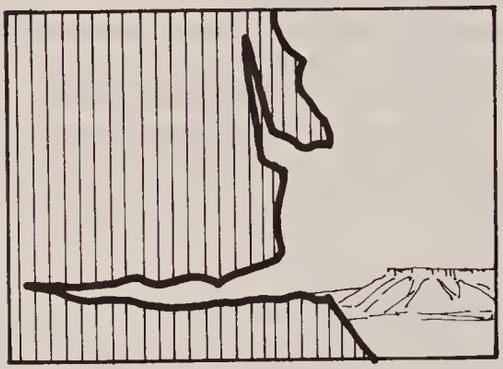
Cliffs of igneous rock (basalt, andesite, and rhyolite) are more important as wildlife habitat in southeastern Oregon than are those of sedimentary rock because they have the most important long-lived features, such as facial cracks or joints, numerous ledges, and occasional deep caves (fig. 3). Cliffs composed of the readily weatherable sedimentary materials occasionally provide shelflike features and holes or pockets (fig. 4).



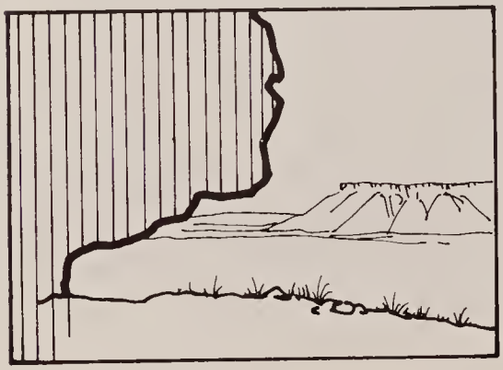
TYPE	FAUNA	USES
FISSURES AND LEDGES	BATS	ROOSTING, REPRODUCTION, HIBERNATION
	RAPTORS	ROOSTING, NESTING, PERCHING



DEEP CLIFF-FACE CAVES	BATS	ROOSTING, REPRODUCTION, HIBERNATION



LOOSE SLABROCK AND FISSURES	SWIFTS	ROOSTING, REPRODUCTION
	BATS	ROOSTING, REPRODUCTION, HIBERNATION
	BATS	ROOSTING, REPRODUCTION, HIBERNATION



SHALLOW CAVES	LIZARDS, SNAKES	SHELTER, FEEDING, HIBERNATION
	MICE, WOODRATS, COYOTES, BOBCATS	SHELTER, REPRODUCTION, NESTING

Figure 3.—Features of cliffs and their uses by wildlife.

Figure 4.—Cliffs of easily weathered materials occasionally have shelflike features and holes or pockets (photo courtesy Bureau of Land Management).

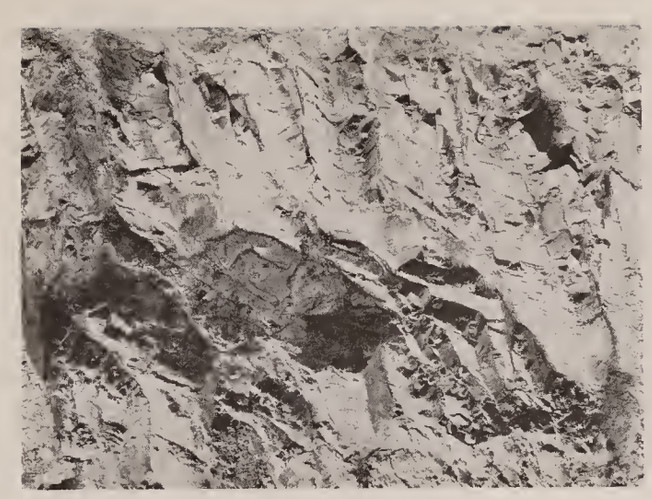


Figure 5.—Cliff swallows use protected areas on cliffs to build their nests and rear their young (photo courtesy Bureau of Land Management).

Cliffs provide secure places for birds to nest and rear young (Bent 1961a, 1961b; Gabrielson and Jewett 1970; Olendorff and Stoddart 1974) (fig. 5). Cliffs also offer shade and some external protection against storms (Fyfe and Olendorff 1976). In addition to physical protection, cliffs produce stable environments within their cracks or joints and caves and thereby buffer environmental extremes.

Most vertebrate animals that use cliffs obtain food and water some distance from those cliffs. A few species feed within or on cliffs. Cliffs next to or within 0.4 kilometer (0.25 mi) of permanent water are far more important for cliff-associated species that require free water (fig. 6).

Most swifts and bats roost and rear their young in cliffs over 12.2 meters (40 ft) in height. The higher a cliff the more habitat it can provide. In addition, the higher a cliff the more predictable the associated thermals or upward-flowing air currents are. These thermals are extensively used by raptors (Craighead and Craighead 1969) and other soaring birds. For example, Denton (1976) found that basaltic cliffs between 7.6 and 30.5 meters (25 and 100 ft) in height were used more that other cliffs by nesting prairie falcons.

Figure 6.—The combination of high cliffs, riparian zones, and a permanent source of water offers excellent wildlife habitat, concentrating a variety of species (photo courtesy Bureau of Land Management).

Cliffs also function as travel routes for some species (fig. 7); they concentrate a variety of reptiles, birds, and mammals into a relatively small, specialized—yet diverse—habitat which, in turn, attracts predators (fig. 8). In fact, cliffs are either essential or disproportionately important to the well-being of a variety of wildlife species (appendix 1).

Figure 7.—An extensive cliff provides habitat for wildlife adapted to cliffs and provides travel routes for some species (photo courtesy Bureau of Land Management).

Figure 8.—Bobcats frequently hunt along cliffs where bushy-tailed woodrats are a favored prey. Note the white woodrat urine on the rock in the lower right of the picture (photo courtesy Robert R. Kindschy; used with permission).

It is important, therefore, to know which combinations of cliff attributes best serve as habitat for which species of vertebrate wildlife in a particular area. From the information contained in figure 2 and tables 1 and 2, the cliffs in a specific area can be characterized in a biologically meaningful way. A matrix can match cliff features with their use by wildlife (appendix 1) and reveal a particular cliff's potential as habitat for wildlife.

Caves

Caves are underground chambers that are open to the surface (fig. 9). They may be shallow or deep and are found in igneous or sedimentary rock (fig. 10). Regardless of type or origin, caves are important habitats for some species of wildlife (McDaniel and Gardner 1977, McDaniel and Smith 1976, McReynolds 1976).

Figure 9.—Caves are underground chambers that are open to the surface—in this case a lava tube (photo courtesy of Bureau of Land Management).

PARENT ROCK

Caves in igneous rock, such as basalt, are more important to cave dwellers than are those in sedimentary rock because igneous rock is more resistant to weathering (table 1) and the caves are usually deeper. For example, most deep caves in southeastern Oregon are lava tubes in basalt flows (Ciesiel and Wagner 1969) (figs. 11 and 12).

Caves in more readily weatherable sedimentary materials tend to be shallow and short lived. They are important primarily as nesting and roosting sites for a variety of birds (appendix 1).

TYPES	FAUNA	USES
SHALLOW CAVES	MICE, WOODRATS COYOTES, BOBCATS	SHELTER, REPRODUCTION, NESTING SHELTER, FEEDING
CLIFF-FACE CAVES	BATS	ROOSTING, REPRODUCTION, HIBERNATION
LAVA TUBES	BATS MICE, WOODRATS	ROOSTING, REPRODUCTION, HIBERNATION SHELTER, REPRODUCTION, NESTING
MINE SHAFTS	BATS MICE, WOODRATS	ROOSTING, REPRODUCTION, HIBERNATION SHELTER, REPRODUCTION, NESTING

Figure 10.—Types of caves and some of their attendant wildlife.

Figure 11.—Lava tubes are usually discovered when the roof collapses, creating an opening to the surface (photo courtesy Bureau of Land Management).

Figure 12.—A collapsed lava tube as seen from inside the tube (photo courtesy Bureau of Land Management).

Caves are divided into two groups based on the resistance of the parent material to weathering (see table 1), and they can be further categorized by diameter and depth (table 3) and degree of darkness. Combinations of these features produce habitat attributes that are exploited by adapted species of wildlife.

Table 3—Structural characteristics of caves that produce habitat attributes which can be exploited by adapted species of wildlife[1]

Structural characteristic	Size class or description
Opening (diameter)	<0.3 meter (<1 foot)
	.03-1 meter (1-3.3 feet)
	>1 meter (>3.3 feet)
Depth of cave (horizontal)	<1 meter (<3.3 feet)
	1-3 meters (3.3-10 feet)
	>3 meters (>10 feet)
Origin	Natural
	Manmade—abandoned mine shaft
	—abandoned railroad tunnel

[1]Appendix 1 illustrates the relationships of wildlife use to these attributes.

IMPORTANCE TO WILDLIFE

Caves offer shelter from weather extremes, physical protection, stable environments, darkness, and seclusion (Barr 1967, Culver 1970, Harris 1970, Poulson and Culver 1969, Poulson and White 1969). For example, the conditions found in deep caves (fig. 13) are essential to some bats (such as the western big-eared bat), which breed, form their nursery colonies, and hibernate in them (Dalquest 1948, Harvey 1976, Mohr 1976, Pearson et al. 1952). Other bats (fig. 14) use caves as night roosts where they periodically hang to digest their food (Barbour and Davis 1969). Caves are also used by a variety of birds and mammals as secure places in which to rear their young, rest, or escape weather extremes.

Deep caves—>3 meters (10 ft)—are scarce in southeastern Oregon; therefore, stable, abandoned mineshafts and railroad tunnels (manmade caves) may provide the same specialized habitats as do natural caves (Barbour and Davis 1969). Shallow caves—<3 meters (10 ft)—on the other hand, are relatively common and are used by a greater variety of wildlife for rearing young, resting, and escaping weather extremes than are deep caves (appendix 1).

From information in tables 1 and 3, caves can be characterized. A matrix comparing cave

features and their use by wildlife (appendix 1) can reveal a particular cave's potential as habitat for wildlife.

Figure 13.—Deep caves in the northern Great Basin are generally lava tubes formed in basalt (photo courtesy Bureau of Land Management).

Figure 14.—The small-footed myotis is occasionally found in caves in southeastern Oregon (photo courtesy Robert R. Kindschy; used with permission).

Talus

Talus is the accumulation of rocks on or at the base of steep slopes, usually cliffs (fig. 15). Important structural components of talus include the length, depth, width of the talus deposit, and the type and size classes of rocks (figs. 16 and 17). The length of time a talus has been established and its stability are also important to resident vertebrate wildlife because a well-established, stable talus offers habitat continuity through many generations of the vertebrate species inhabiting it.

Figure 15.—Talus is an important habitat in the Great Basin (photo courtesy Robert R. Kindschy; used with permission).

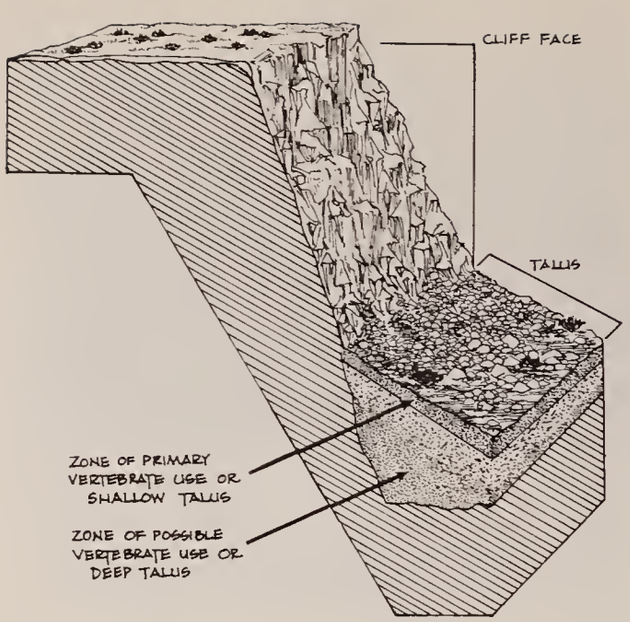


Figure 16.—Talus—the accumulation of rocks that normally occur at the bases of cliffs.

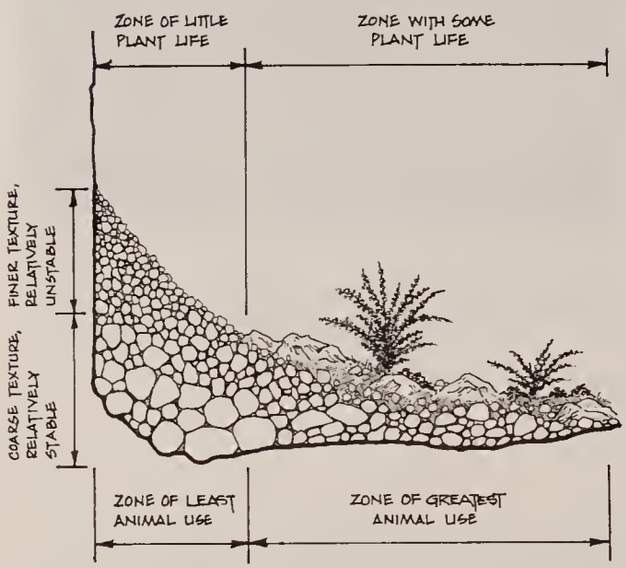


Figure 17.—Anatomy of talus and its use by wildlife.

PARENT ROCK

In general, a large, deep, stable talus field of igneous rock provides better wildlife habitat than does a smaller talus field or talus composed of weakly consolidated sedimentary rock. The latter is not as stable or enduring as the former.

The best talus habitats are generally associated with the toeslopes of cliffs (shapes 1, 2, and 3 in fig. 2). Rocks from these cliffs are mostly large and weather resistant, and resultant talus fields become large, deep, and stable. Talus class (table 4) is important because rock size determines the spaces between rocks which, in turn, determines the size of animals that can inhabit the talus. Rock size also determines which species of vertebrates can use the rocks for sunning or as lookout sites. For example, class II talus may be large enough to serve as lookouts for collared lizards (fig. 18) but is usually too small to serve as lookouts for yellow-bellied marmots.

Table 4—Talus class, based on the predominant or most common rock size in the talus field[1]

Talus class	Rock size (diameter)
I	< 0.5 meter (< 1.6 feet)
II	0.5-1 meter (1.6-3.3 feet)
III	1-2 meters (3.3-6.5 feet)
IV	> 2 meters (> 6.5 feet)

[1]Rock size (talus class) determines the size of the spaces between rocks which, in turn, determine which animals can inhabit those spaces. Appendix 1 illustrates the relationships of wildlife use to talus class.

Figure 18.—Collared lizards are usually associated with class II talus, especially scattered talus on sparsely vegetated hillsides. They use the large rocks as lookouts (photo courtesy Robert R. Kindschy; used with permission).

Figure 19.—Lava stringers generally appear as elongated surface concentrations of rock with physical structures similar to talus. Note that the lava stringers have no visible connections to the cliffs. Many, or most, such stringers occur where there are no cliffs.

TALUSLIKE HABITATS

In addition to talus fields, there are taluslike habitats, such as lava stringers, collapsed lava tubes, mine tailings, and roadside "talus."

Lava stringers generally appear as elongated concentrations of rock (fig. 19), possessing a structure similar to talus. Most lava stringers are composed of basalt and are class I talus. Only small wildlife can use these stringers (appendix 1) for rearing young or for hibernation.

Collapsed lava tubes have piles of rock rubble in the area of collapse (fig. 20). Such rubble frequently provides structural features similar to class II talus.

Figure 20.—Collapsed lava tubes frequently have piles of rock rubble in the collapse area that provide structural features similar to talus (photo courtesy Bureau of Land Management).

Mine tailings, particularly from hard-rock mines, provide taluslike structure. The rock interspaces, however, are often filled with fine materials, limiting their value as wildlife habitat. In addition, early placer mining activity commonly created piles of river rock corresponding to class I talus. Current hard-rock mining activities, on the other hand, produce mine tailings which usually are a mixture of coarse and fine materials corresponding to classes I and II talus. Most of the spaces between the large rocks are filled in by fine materials and are not usable by wildlife.

Roadside "talus" is composed of rock used in construction of roadbeds and can usually be classified in talus class I or II. This can be an important habitat feature because it provides habitat for a variety of vertebrate wildlife in otherwise unsuitable habitat. Such roadside "talus" allows some species to extend their habitats far into otherwise unsuitable areas. It is also possible for roadside "talus" to serve as a connector between natural talus habitats.

IMPORTANCE TO WILDLIFE

Talus provides protection, particularly for reproduction and hibernation, for animals living adjacent to or within it. The environment within a deep talus is more stable and benign than that above it, an important feature during hot summers and cold winters (Krear 1965). Because of its stability, talus is an important geomorphic habitat for ground-dwelling vertebrates, providing diversity over time. Talus also produces an environment that favors an edge of herbaceous vegetation which forms the food supply for vertebrates associated with the talus.

Talus provides a habitat that concentrates lizards, snakes, birds, and mammals; and predators are in turn attracted (appendix 1). From tables 1 and 4, talus can be characterized. Additional descriptors, such as length, depth, and width, of a talus or taluslike formation and its further identification as hillside talus, lava stringer, collapsed lava tube, mine tailing, or roadside talus can provide a meaningful description of a talus. When combined with the data in appendix 1, a talus' potential as wildlife habitat can be predicted.

Lava Flows

There are many old lava flows composed primarily of basalt and andesite (Ciesiel and Wagner 1969, Russell 1903, Walker 1977) which ". . .while molten [were]. . .extruded by volcanoes so as to form sheets which, in many instances, flowed far and wide over the surface of the land before cooling" (Russell 1903, p. 64). McKee (1972, p. 240) asserted that southeastern Oregon "has one of the world's best displays of volcanic landforms." Although most of these lava flows are old (more than 20,000 years, Russell 1903), at least one flow is very young, 4,000 to 9,000 years (Kindschy and Maser 1978, Otto and Hutchison 1977) (figs. 21 and 22).

Figure 21.—Old lava flows (over 20,000 years of age) are fragmented and are covered with varying amounts of soil and vegetation (photo courtesy Robert R. Kindschy; used with permission).

Figure 22.—A recent lava flow (4,000 to 9,000 years old) is often too young for soil or vegetative cover to have developed over its entirety and is, therefore, best suited for habitation of vertebrates around the margin (photo courtesy Robert R. Kindschy; used with permission).

IMPORTANCE TO WILDLIFE

The old flows are fragmented with crevices and are covered with varying amounts of soil and vegetation. The composition and structure of this vegetation commonly differ from the composition and structure of the surrounding rangeland vegetation. Old lava flows create areas of rock rubble of a size similar to talus classes II, III, and IV (table 4). These features combine to form a diversity of habitats caused by the many combinations of talus structure, vegetational structure, and edges of varying contrasts (fig. 21). The mix of habitat attributes associated with old lava flows permits a variety of vertebrate wildlife to concentrate into small areas (appendix 1).

Wildlife may obtain food and both hiding and thermal cover within old lava flows, but in young flows (fig. 22) they normally have to obtain food along the periphery because of the lack of vegetation toward the centers of such flows (appendix 1) (Kindschy and Maser 1978). Lava flows provide crevices of varying depths, as well as shallow caves and lava tubes. These are used by wildlife for rearing young, hibernating, and storing food. In addition, lava flows often protect wildlife habitat from disturbance by cattle which tend to avoid such rocky areas.

Sand Dunes

Sand dunes (fig. 23) in the Great Basin are uncommon and are usually associated with winds' erosion of prehistoric lakebeds (Allison 1966, Baldwin 1976, Butzer 1976, McKee 1972).

Figure 23.—Active sand dunes in the Great Basin are associated with erosion by wind and are limited in distribution (photo courtesy Bureau of Land Management).

IMPORTANCE TO WILDLIFE

Sand dunes, particularly those partially stabilized with vegetation (fig. 24), are important habitat for a variety of vertebrate wildlife (appendix 1).

Figure 24.—Partially stabilized sand dunes are important habitat for both prey and predators, such as the bobcat (photo courtesy Bureau of Land Management).

Although relatively few vertebrates are specifically adapted to sand dunes, some species, such as kangaroo mice and kangaroo rats, are adapted to travel on loose sand but are weak diggers and fare particularly well in sand dunes. These animals easily travel and forage in loose sand and can readily burrow in sand stabilized by vegetation; they exploit food resources along dune edges. They obtain sufficient moisture from their food and do not require free water. In turn, these species are hunted by predators, such as the kit fox (Egoscue 1975, Laughrin 1970, Snow 1973b)—which is listed as threatened in Oregon (Benedict and Forbes 1979, Oregon Department of Fish and Wildlife 1977). Stabilized sand dunes are important, potential hunting grounds for kit foxes (Egoscue 1962).

Playas

Playas are shallow desert basins into which water drains after rainstorms or as snow melts (fig. 25). Playas do not have natural external drainageways, and water is seasonally retained in the basin (Butzer 1976, McKee 1972). Some of the collected water in the playas evaporates and leaves behind once dissolved salts. These salts accumulate as the process is repeated over time.

Because of salts, playas have distinctive plant communities (Bernstein 1962, Brown 1977, Chapman 1960, Magistad 1945, Robinson 1958). Motts (1965) and Neal (1965, 1968a, 1969) have written overview papers on playas.

IMPORTANCE TO WILDLIFE

Playas containing water are important feeding and nesting habitat for some water birds. In addition, during spring and fall migrations, playas containing water are important resting places for waterfowl (appendix 1).

Erosion by wind is common within playas, and the fine materials that are blown out often form into dunes surrounding the deflation plain or basin of a playa (Butzer 1976). Sand dunes and playas frequently occur together, creating more diversity of habitat than where they occur alone.

Figure 25.—A playa basin acts as a catchment. Since a playa has no natural external outlet, the water evaporates and leaves behind the once dissolved salts (photo courtesy Robert R. Kindschy; used with permission).

Edaphic Habitats

Edaphic habitats are specific combinations of soils and vegetation that provide a set of habitat attributes required by certain species of wildlife (fig. 26). Only in circumstances of extreme instability, such as dunes, is vegetation absent. Although edaphic habitats occur virtually everywhere, the edaphic habitat is of special interest in the northern Great Basin because it is the primary habitat of the antelope ground squirrel[2] and is the only habitat for several native endemic plants.[3] [4]

Boundaries between edaphic and other habitats are often sharp. Such boundaries are recognized by changes in vegetative composition, or density, or both. Differences in

[2]Maser, Chris, 1975-77. Unpublished data on file at Puget Sound Museum of Natural History, Univ. Puget Sound, Tacoma, Wash.

[3]Packard, Patricia, 1978. Personal communication. Coll. Idaho, Caldwell.

[4]Soil scientists can help identify the soil which we tentatively classified as a vertic intergrade of a Calcic Argixeroll, shallow, fine loamy, mixed, mesic. It occurs within a more general mapping unit number 60 in a survey of irrigability of southeastern Oregon landscapes (Lovell et al. 1969).

Figure 26.—The light areas in the middle one-third of this photograph exemplify an edaphic habitat of special interest; in southeastern Oregon this is the primary habitat of the antelope ground squirrel (photo courtesy Robert R. Kindschy; used with permission).

species composition and density may be reflected in the structure of the respective plant communities.

The soil has four color phases and is derived from deposits of old lake sediments (lacustrine). Colors of the phases are varied and include the following: light gray (10 YR 7/2), yellowish brown (10 YR 5/8), light olive gray (5 YR 6/2), and reddish brown (2.5 YR 4/4).[5]

The phases are also recognized, when dry, by their soft, loose, almost spongy surfaces which compress 1 to 3 centimeters (0.4-1.2 in) in depressions left by human footprints. The soil surface may be partially covered by flat (platy), coarse, gravel-sized fragments, but most of the surface is composed of smaller, granular particles less than 0.5 millimeter (0.02 in) in diameter. Soil depths are shallow, less than 50 centimeters (20 in). Surface layers are moderately fine textured, and lower layers are higher in clay. A weakly consolidated, though partially fractured, bedrock is usually encountered within 0.3 meter (1 ft) of the surface.

Subsoils shrink and swell markedly during drying and wetting, respectively. During drying, cracks of 2 to 4 centimeters (0.8-1.6 in) appear at the soil surface. These openings speed drying and expose plant roots to severe environmental stress.

The plant community is usually dominated by a meager cover of desert shrubs whose roots extend deep into bedrock fractures. Vegetative structure may be dominated by low, rounded shrubs, such as spiny saltbush (*Atriplex confertifolia*), bud sage (*Artemisia spinescens*), and broom snakeweed (*Gutierrezia sarothrae*); or by tall shrubs, such as big sagebrush (*Artemisia tridentata*), spiny hopsage (*Atriplex spinosa*), or rabbitbrush (*Chrysothamnus* spp.). The associated herbaceous species are easily uprooted from dry, loose soil and tend to be predominantly annuals, mainly cheatgrass (*Bromus tectorum*). Perennial species, such as bottlebrush squirreltail (*Sitanion hystrix*), Sandberg bluegrass (*Poa sandbergii*), bluebunch wheatgrass (*Agropyron spicatum*), buckwheats (*Eriogonum* spp.), and pigweed (*Amaranthus* sp.), may also be present.

IMPORTANCE TO WILDLIFE

Although a few wildlife species may be found on one or more of the phases (appendix 1), the antelope ground squirrel is the only species specifically adapted to this habitat. Adapted primarily to hot deserts of the southwestern United States and Baja California, Mexico, the antelope ground squirrel reaches the northernmost limits of its geographical distribution in the Great Basin of southeastern Oregon, where the edaphic habitat simulates the hot desert.

Appendix 1 shows vertebrates known to be associated with this habitat.

[5]Color names and numerical designations follow those of Munsell Color Company, Inc., Baltimore, Maryland. Use of trade, firm, or corporation names is for the information and convenience of the reader and does not constitute an official endorsement or approval by the U.S. Department of Agriculture or by the U.S. Department of the Interior.

Management Tips

Geomorphic habitats are usually local and occupy a small percentage of the total land base. These habitats cannot be artificially created without great expense or with any assurance that wildlife will use them. They can be destroyed. Manmade "geomorphic" habitats are incidentally used by wildlife when they closely simulate natural habitats. For example, raptors and rock doves may nest in old rock quarries (Kindschy 1964, Murphy et al. 1969); bats may use abandoned mineshafts (Barbour and Davis 1969); and yellow-bellied marmots, ground squirrels, and chipmunks may use roadside talus.

Each geomorphic habitat has at least one animal highly adapted to it for reproduction. Each habitat also concentrates and supports a peculiar animal complex; therefore, plant communities adjacent to these habitats are best maintained as an integral component of the geomorphic habitat since they provide the source of food for the animals (Call 1978).

Removal or alteration of the habitat usually eliminates animals dependent on that habitat. Some animals can be locally extirpated by human disturbance or travel on access roads or trails in the proximity of their habitats. This is most likely when the animals are actively rearing young (Olendorff and Stoddart 1974). If wildlife associated with geomorphic and edaphic habitats are of concern to a manager, access roads and trails, when possible, should be located to avoid unnecessary disturbance to geomorphic or edaphic habitats identified as critical. If an alternate route is not available, travel could be curtailed or kept to a minimum during the reproductive season of the wildlife species of interest.

CLIFFS

Each cliff has attributes that are valuable as habitat for wildlife. For example, vertical cracks or joints, by their size and number, affect the quality and kind of wildlife habitat. Cliffs are vertical, and features cannot be readily described from aerial photographs.

The amount of bushy-tailed woodrat urine visible along a cliff is a good index to general use of a particular cliff by wildlife. Because the bushy-tailed woodrat is usually the largest animal to inhabit the cracks or joints, its presence in numbers usually means that such joints offer ample living space to smaller animals. As a rule, the more woodrat urine visible on a cliff face, the greater the use by wildlife in general.

CAVES

Cave-dwelling bats, such as western big-eared bats, are easily eliminated by human disturbance—cave exploration, artifact hunting, building fires within a cave, and general vandalism (Bailey 1936, Graham 1966). It is therefore advisable not to advertise the location of a cave unless the intent is to develop it specifically for recreational purposes.

Scientific data and resultant management strategies for caves have been developed (see, for example, Aley and Rhodes 1977). Such data can be used to develop management objectives for a specific cave to emphasize either recreation (Tousley 1976) or wildlife (Keith 1977). The wildlife values should be carefully weighed before a decision is made, since deep caves are scarce and development is likely to destroy much or most of a cave's value as habitat for wildlife.

TALUS

There frequently is a temptation to use talus as a ready source of material for roadbeds, but talus concentrates a variety of wildlife species into a small area and provides an important habitat. In fact, talus is critical to the survival of such species as collared lizards over much of their range (Fitch 1956, Storm 1966). Removal of talus destroys the habitat; thus, any anticipated management action should be carefully weighed in the planning process.

Management of mine tailings as wildlife habitat should be done with care because tailings from some mines are toxic to various species of animals (Porter and Hakanson 1976). Such toxicity may limit the utility of tailings as habitat for specific species of wildlife. Cook and Bonham (1977) discussed techniques for sampling vegetation on mine tailings—an equally important consideration in terms of potential management of tailings as wildlife habitat.

LAVA FLOWS

Lava flows are durable and endure most rangeland management activities without visible deleterious effects. But road construction through a lava flow or removal of a portion of a lava flow for use as roadbed material or commercial building materials does alter the wildlife habitat.

SAND DUNES

Sand dunes that are either partially or completely stabilized by vegetation are vulnerable to forces that deteriorate them, particularly livestock and off-road vehicles (Busack and Bury 1974, Sheridan 1978, Snyder et al. 1976). These uses of stabliized dunes destroy the existing vegetation and thereby increase erosion by wind which alters the quality of habitat for wildlife.

If sand dunes are managed as wildlife habitat, the exclusion of other uses should be considered. Some areas, however, could be selected and managed with recreation, such as off-road vehicle use, as the primary objective. In fact, regulations have been formulated for off-road vehicles on public lands (Davey 1974, p. 369):

> No person shall operate an off-road vehicle on public lands: (a) in a reckless, careless, or negligent manner; (b) in excess of established speed limits; (c) while under the influence of alcohol or drugs; (d) in a manner likely to cause excessive damage to or disturbance of the land, wildlife, or vegetative resources. . . .

It seems doubtful that enough forage exists on sand dunes to warrant the risk of increasing their inherent instability through grazing by livestock.

PLAYAS

If playas are to be managed as habitat for wildlife, then the best strategy probably is to protect the playa, its attendant sand dunes, and the adjacent rangelands from the impacts of livestock grazing and off-road vehicle enthusiasts (Bury et al. 1977, Sheridan 1978, Snyder et al. 1976).

Where a shallow playa is a habitual resting place for migratory waterfowl, it may be desirable to deepen a portion of the basin to increase water retention and, thereby, use by waterfowl. This could be done without altering the structure of the entire playa.

EDAPHIC HABITATS

The nature of the edaphic habitat makes it droughty and unstable. As such, it is fragile and particularly vulnerable to grazing by livestock and to off-road vehicular travel (Bury et al. 1977, Sheridan 1978, Snyder et al. 1976). Such activities accelerate erosion by wind and water which makes the habitat less suitable for plant growth and leads to deterioration as habitat for wildlife. Snyder et al. (1976, p. 30) summed it up: ". . . the effects of off-road vehicle use in arid and semiarid environments are both serious and of long duration."

If protection of habitat for endemic plants and for wildlife is the objective, it should be considered a positive management alternative. This may be most easily accomplished by fencing. Fencing retains maximum flexibility for managing the surrounding rangelands.

A healthy plant community helps retain soil and nutrients that favor stability. Over time, this produces or maintains good habitat for vertebrates associated with edaphic habitats.

Summary

Geomorphic habitats are the products of geologic or geomorphic processes, and edaphic habitats are combinations of vegetation and soils. These habitats "come issued" with the land and cannot, for the most part, be created through land management activities. They provide diversity of habitat in large expanses of otherwise relatively homogeneous landscapes, and this is reflected in increased diversity of wildlife.

Geomorphic and edaphic habitats occupy a small percentage of the total land area in the Great Basin. Some, such as deep caves, sand dunes, playas, and local, distinctive soils, are comparatively rare habitats.

Range management activities involving the alteration or disturbance of geomorphic and edaphic habitats should be carefully evaluated because some wildlife species, such as the threatened kit fox, are highly susceptible to alteration of habitat (Oregon Department of Fish and Wildlife 1977). These habitats should, therefore, be examined by wildlife experts during the planning process to insure their proper management.

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Appendix 1

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Appendix 2

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Appendix 1

Generalized Response of Terrestrial Species of Vertebrate Wildlife to Geomorphic and Edaphic Habitats

Legend: r = reproduction; f = feeding; o = other (cover, travel, observation, etc.); x = use; CAPITALS = "essential habitat" for the species

WILDLIFE SPECIES	FEATURES					CLIFFS																	
						STRUCTURAL CHARACTERISTICS																	
						Height class				Length class					Joint spacing (between joints)					Joint width (opening)				
Common name	Caves	Rock shelters	Loose slabs	Ledges	Fissures	<3 m	3–10 m	10–30 m	>30 m	<30 m	30–100 m	100–500 m	500–1 500 m	>1 500 m	>30 m	7.5–30 m	1.5–7.5 m	0.3–1.5 m	<0.3 m	<0.15 m	0.15–0.30 m	0.3–0.6 m	0.6–1.5 m	>1.5 m
Amphibians																								
long-toed salamander					fo	x	x	x	x											fo				
Great Basin spadefoot																								
western toad	fo	fo	fo			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Woodhouse toad	fo	fo	fo			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pacific tree frog	fo	fo	fo			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
spotted frog																								
leopard frog																								
bullfrog																								
Reptiles																								
collared lizard			rfo		rfo	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
leopard lizard																								
western fence lizard	rfo	rfo	rfo	fo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
sagebrush lizard																								
side-blotched lizard	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
desert horned lizard																								
short-horned lizard																								
western skink																								
western whiptail																								
rubber boa						x	x	x	x	x	x	x	x	x										
yellow-bellied racer		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
striped whipsnake		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x										
gopher snake																								
common garter snake			fo																					
wandering garter snake			fo																					
western ground snake	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
night snake	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
western rattlesnake	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Birds																								
common loon																								
red-necked grebe																								
horned grebe																								
eared grebe																								
western grebe																								
pied-billed grebe																								
American white pelican									o					o										
double-crested cormorant				RO			RO	RO	RO			RO	RO	RO										
great blue heron				o																				
green heron																								
cattle egret				o																				
common egret				o																				
black-crowned night heron																								
American bittern																								
least bittern																								
white-faced ibis																								
whistling swan																								
Canada goose				r			r	r	r	r	r	r	r	r										
white-fronted goose																								
snow goose																								
Ross' goose																								
mallard			r	ro	r	ro	ro	ro	ro	ro	ro	ro	ro	ro	r	r	r	r	r		r	r	r	r
gadwall								o	o			o	o	o										
common pintail								o	o			o	o	o										
green-winged teal								o	o			o	o	o										
blue-winged teal								o	o			o	o	o										
cinnamon teal								o	o			o	o	o										
American wigeon								o	o			o	o	o										
northern shoveler								o	o			o	o	o										
wood duck								o	o			o	o	o										
redhead								o	o			o	o	o										
ring-necked duck								o	o			o	o	o										
canvasback								o	o			o	o	o										
greater scaup								o	o			o	o	o										
lesser scaup								o	o			o	o	o										
common goldeneye								o	o			o	o	o										

ASSOCIATIONS		CAVES										TALUS									LAVA FLOWS		SAND DUNES		PLAYAS		EDAPHIC HABITATS
Proximity to water		TYPES				CHARACTERISTICS						TYPES					CLASSES, by size of rock (diameter)										
						Opening size (diameter)			Depth (horizontal)																		
<0.4 km	>0.4 km	Shallow caves	Cliff-face caves	Lava tubes	Mine shafts	<0.3 m	0.3–1 m	>1 m	<10 dm	10–30 dm	>30 dm	Cliff talus	Lava stringers	Collapsed lava tubes	Mine tailings	Roadside talus	I	II	III	IV	Old	New	Stabilized	Active	Alkaline	Fresh	
FO												fo	fo	fo	fo	fo	x	x	x							RF	
												fo	fo	fo	fo	fo	x	x	x							RFO	
FO		fo		fo	fo	x	x	x	x	x	x	fo	fo	fo	fo	fo	x	x	x	x						RF	
FO		fo		fo	fo	x	x	x	x	x	x	fo	fo	fo	fo	fo	x	x	x	x						RF	
FO		fo		fo	fo	x	x	x	x	x	x	fo	fo	fo	fo	fo	x	x	x	x						RF	
																										RFO	
FO												fo	fo	fo	fo	fo	x	x	x								
x	x											RFO	RFO	RFO	RFO	RFO	X	X	X	X	X						
																							RF		fo	fo	rfo
x	x	rfo				x			x			rfo	rfo	rfo	rfo	rfo	x	x	x	x	rfo	rfo					
												rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x				fo
x	x	rfo	rfo	rfo	rfo	x	x	x	x			rfo	rfo	rfo	rfo	rfo	x	x	x	x	x						
																							rfo	x			
																							rfo	x			
												rfo	rfo	rfo	rfo	rfo	x	x	x	x			rfo				
												rfo	rfo	rfo	rfo	rfo	x	x	x	x			rfo	x			x
X												rfo	rfo		rfo	rfo	x	x	x	x							
x	x	fo	fo	fo	fo	x	x	x	x			RFO	RFO	RFO	RFO	RFO		X	X	X							
x	x											rfo	rfo	rfo	x	x		x	x	x							x
		fo				x	x	x	x			rfo	rfo	rfo	rfo	rfo	x	x	x	x							
X												rfo	rfo	rfo	rfo	rfo	x	x	x					x			
X	X	fo	fo	fo	fo	x	x	x	x			rfo	rfo	rfo	rfo	rfo	x	x	x					x			
x	x											RFO	RFO				X	X	X	X							
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x							
x	x	rfo		rfo	rfo	x	x	x	x			RFO	RFO	RFO	RFO	RFO	X	X	X	X							
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Appendix 1 (continued)

Generalized Response of Terrestrial Species of Vertebrate Wildlife to Geomorphic and Edaphic Habitats

Legend: r = reproduction; f = feeding; o = other (cover, travel, observation, etc.); x = use; CAPITALS = "essential habitat" for the species

WILDLIFE SPECIES	FEATURES					CLIFFS																			
						STRUCTURAL CHARACTERISTICS																			
						Height class				Length class					Joint spacing (between joints)					Joint width (opening)				
	Caves	Rock shelters	Loose slabs	Ledges	Fissures	<3 m	3–10 m	10–30 m	>30 m	<30 m	30–100 m	100–500 m	500–1 500 m	>1 500 m	>30 m	7.5–30 m	1.5–7.5 m	0.3–1.5 m	<0.3 m	<0.15 m	0.15–0.30 m	0.3–0.6 m	0.6–1.5 m	>1.5 m
Barrow's goldeneye								o	o			o	o	o										
bufflehead								o	o			o	o	o										
oldsquaw								o	o			o	o	o										
King eider								o	o			o	o	o										
ruddy duck								o	o			o	o	o										
hooded merganser								o	o			o	o	o										
common merganser			ro	ro	ro	ro	ro	ro	ro	ro	ro	ro	ro	ro								ro	ro	ro
red-breasted merganser								o	o			o	o	o										
turkey vulture	RO	FO		RO		FO	FO	R	R	X	X	X	X	X										
northern goshawk		f		f		f	f	f	f	f	f	f	f	f										
sharp-shinned hawk		f		f		f	f	f	f	f	f	f	f	f										
Cooper's hawk		f		f		f	f	f	f	f	f	f	f	f										
red-tailed hawk				rfo				r	r	rfo	rfo	rfo	rfo	rfo										
Swainson's hawk				fo		fo	fo	fo	fo	fo	fo	fo	fo	fo										
rough-legged hawk				fo		fo	fo	fo	fo	fo	fo	fo	fo	fo										
ferruginous hawk			rfo	RFO		RFO	RFO	RFO	RFO	RFO	RFO	RFO	RFO	RFO										
golden eagle				RFO				RFO	RFO	RFO	RFO	RFO	RFO	RFO										
bald eagle				fo				fo	fo	fo	fo	fo	fo	fo										
northern harrier						fo	fo	fo	fo	fo	fo	fo	fo	fo										
osprey				ro				ro	ro		ro	ro	ro	ro										
prairie falcon		RFO		RFO				RFO	RFO	RFO	RFO	RFO	RFO	RFO										
peregrine		RFO		RFO					RF	RFO	RFO	RFO	RFO	RFO										
merlin				rfo				rfo	rfo	rfo	rfo	rfo	rfo	rfo										
American kestrel			rfo		RFO		rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	r	r	r	r	r			r		
blue grouse						f	f	f	f	f	f	f	f	f										
ruffed grouse																								
sage grouse						fo	fo	fo		fo	fo	fo												
California quail			ro	fo	o	rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x	x	x	x
mountain quail			rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x	x	x	x
chukar		RFO	RFO	RFO	RFO	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x
gray partridge				f		fo	fo			fo	fo	fo	fo	fo										
ring-necked pheasant				f		fo	fo			fo	fo	fo	fo	fo										
sandhill crane																								
Virginia rail																								
sora																								
American coot			ro			x	x			x	x	x	x	x										
snowy plover								o	o			o	o	o										
killdeer								o	o			o	o	o										
mountain plover								o	o			o	o	o										
common snipe								o	o			o	o	o										
long-billed curlew				fo		x	x	x	x	x	x	x	x	x										
semi-palmated plover								o	o			o	o	o										
spotted sandpiper								o	o			o	o	o										
solitary sandpiper								o	o			o	o	o										
greater yellowlegs								o	o			o	o	o										
lesser yellowlegs								o	o			o	o	o										
willet								o	o			o	o	o										
pectoral sandpiper								o	o			o	o	o										
Baird's sandpiper				fo	fo			fo	fo			fo	fo	fo										
least sandpiper								o	o			o	o	o										
western sandpiper				fo	fo			fo	fo			fo	fo	fo										
long-billed dowitcher								o	o			o	o	o										
marbled godwit								o	o			o	o	o										
American avocet								o	o			o	o	o										
black-necked stilt								o	o			o	o	o										
Wilson's phalarope								o	o			o	o	o										
northern phalarope								o	o			o	o	o										
herring gull								o	o			o	o	o										
California gull								o	o			o	o	o										
ring-billed gull								o	o			o	o	o										
Franklin's gull								o	o			o	o	o										
Bonaparte's gull								o	o			o	o	o										
Forster's tern								o	o			o	o	o										
Caspian tern								o	o			o	o	o										
black tern								o	o			o	o	o										
rock dove		RFO	RFO	RFO	RFO		RFO	RFO	RFO	RFO	RFO	RFO	RFO	RFO										
mourning dove								o	o			o	o	o										
yellow-billed cuckoo			fo	fo	fo	x	x			x	x	x	x	x										
barn owl	RFO	RFO	RFO	RFO	RFO		RFO	RFO	RFO	rfo	rfo	rfo	rfo	rfo								r	r	r

ASSOCIATIONS		CAVES										TALUS									LAVA FLOWS		SAND DUNES		PLAYAS		EDAPHIC HABITATS
Proximity to water		TYPES				CHARACTERISTICS: Opening size (diameter)			CHARACTERISTICS: Depth (horizontal)			TYPES					CLASSES, by size of rock (diameter)										
<0.4 km	>0.4 km	Shallow caves	Cliff-face caves	Lava tubes	Mine shafts	<0.3 m	0.3—1 m	>1 m	<10 dm	10—30 dm	>30 dm	Cliff talus	Lava stringers	Collapsed lava tubes	Mine tailings	Roadside talus	I	II	III	IV	Old	New	Stabilized	Active	Alkaline	Fresh	
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o																										fo	
X	X											x	x	x	x	x	x	x	x	x							
x	x											x	x				x	x	x	x							
x	x											x	x				x	x	x	x							
x	x											x	x				x	x	x	x							
x	x											x	x	x	x	x	x	x	x	x							
fo	fo											f	f	f	f	f	x	x	x	x	fo	fo				fo	
fo	fo											f	f	f	f	f	x	x	x	x	fo	fo				fo	
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	rfo	rfo				fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	fo	fo				fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	fo	fo				fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	fo	fo				fo	
x																										o	
x	x											fo	fo	fo	fo	fo	x	x	x	x	fo	fo				fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	fo	fo				fo	
x	x																									fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	fo	fo				fo	
x												rfo					x	x	x	x							
x	x												x	x			x	x	x	x							
x												rfo	rfo	rfo			x	x	x	x							
x												RFO	RFO	RFO			X	X	X	X							
X												rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x					
x	x											fo	fo	fo	fo	fo	x	x	x	x			x				
x												rfo					x	x	x	x			x				
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x												fo	fo	fo	fo	fo	x	x	x	x							
X	X	R	R	R	R	r	r			r	r	f	f	f	f	f	x	x	x	x	x		x			f	

Appendix 1 (continued)

Generalized Response of Terrestrial Species of Vertebrate Wildlife to Geomorphic and Edaphic Habitats

Legend: r = reproduction; f = feeding; o = other (cover, travel, observation, etc.); x = use; CAPITALS = "essential habitat" for the species

WILDLIFE SPECIES	FEATURES					CLIFFS																		
						STRUCTURAL CHARACTERISTICS																		
						Height class				Length class					Joint spacing (between joints)					Joint width (opening)				
	Caves	Rock shelters	Loose slabs	Ledges	Fissures	<3 m	3–10 m	10–30 m	>30 m	<30 m	30–100 m	100–500 m	500–1 500 m	>1 500 m	>30 m	7.5–30 m	1.5–7.5 m	0.3–1.5 m	<0.3 m	<0.15 m	0.15–0.30 m	0.3–0.6 m	0.6–1.5 m	>1.5 m
common screech owl	RFO	RFO	RFO	RFO	RFO		RFO	RFO	RFO	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		r	r		
flammulated owl			fo	fo	fo		fo	fo	fo	fo	fo	fo	fo	fo	x	x	x	x	x	x	x			
great horned owl	RFO	RFO	RFO	RFO	RFO		x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x
pygmy owl		fo	fo	fo	fo		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
burrowing owl		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
long-eared owl																								
short-eared owl																								
saw-whet owl		fo	fo	fo	fo		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
poorwill				rfo		x	x	x	x	x	x	x	x	x										
common nighthawk				rfo		x	x	x	x	x	x	x	x	x										
black swift				f	RO			X	X	X	X	X	X	X	x	x	x	x	x	x				
Vaux's swift				f	RO			X	X	X	X	X	X	X	x	x	x	x	x	x				
white-throated swift			RO	f	RO			X	X	X	X	X	X	X	x	x	x	x	x	x				
black-chinned hummingbird																								
Anna's hummingbird																								
broad-tailed hummingbird																								
rufous hummingbird																								
calliope hummingbird																								
belted kingfisher																								
common flicker			fo	fo			x	x	x	x	x	x	x	x										
Lewis' woodpecker			fo	fo			x	x	x	x	x	x	x	x										
yellow-bellied sapsucker																								
Williamson's sapsucker																								
hairy woodpecker																								
downy woodpecker																								
white-headed woodpecker																								
eastern kingbird			fo	fo	fo		x	x	x	x	x	x	x	x								x	x	x
western kingbird			rfo	rfo	rfo		x	x	x	x	x	x	x	x								x	x	x
ash-throated flycatcher				fo	fo		x	x	x	x	x	x	x	x										
Say's phoebe	RFO	RFO	RFO	RFO	RFO	x	x	x	x	x	x	x	x	x								x	x	x
willow flycatcher				fo	fo		x	x	x	x	x	x	x	x										
Hammond's flycatcher				fo	fo		x	x	x	x	x	x	x	x										
gray flycatcher				fo	fo		x	x	x	x	x	x	x	x										
western flycatcher				fo	fo		x	x	x	x	x	x	x	x										
western wood pewee			rfo	rfo	rfo		x	x	x	x	x	x	x	x										
olive-sided flycatcher				fo	fo		x	x	x	x	x	x	x	x										
horned lark		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x						x	x	x	x	x
violet-green swallow				fo			x	x	x	x	x	x	x	x										
tree swallow				fo			x	x	x	x	x	x	x	x										
bank swallow				fo			x	x	x	x	x	x	x	x										
rough-winged swallow				fo			x	x	x	x	x	x	x	x										
barn swallow		RFO	RFO	RFO	RFO			x	x	x	x	x	x	x								x	x	x
cliff swallow		RFO	RFO	RFO	RFO			x	x	x	x	x	x	x								x	x	x
gray jay																								
Stellar's jay																								
scrub jay				fo		x	x	x	x	x	x	x	x	x										
black-billed magpie		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x									x	x
northern raven		RFO	RFO	RFO	RFO			x	x		x	x	x	x										x
American crow		fo	fo	fo	fo		x	x	x	x	x	x	x	x										x
pinyon jay		fo	fo	fo	fo		x	x	x															
Clark's nutcracker	fo	fo	fo	fo	fo		x	x	x		x	x	x	x										
black-capped chickadee		rfo	rfo	rfo	rfo		x	x	x	x	x	x	x	x						x	x	x	x	x
mountain chickadee		fo	fo	fo	fo		x	x	x	x	x	x	x	x						x	x	x	x	x
bushtit			fo	fo	fo	x	x	x	x	x	x	x	x	x						x	x	x	x	x
white-breasted nuthatch																								
red-breasted nuthatch																								
brown creeper																								
dipper				RO		x	x	x	x	x	x	x	x	x						x	x			
house wren		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
winter wren		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
marsh wren																								
canyon wren		RFO	RFO	RFO	RFO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
rock wren		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
gray catbird																								
brown thrasher																								
sage thrasher																								
American robin				o		x	x	x	x	x	x	x	x	x										
varied thrush				o		x	x	x	x	x	x	x	x	x										
hermit thrush			rfo	rfo	rfo	x	x	x	x	x	x	x	x	x										

ASSOCIATIONS		CAVES										TALUS									LAVA FLOWS		SAND DUNES		PLAYAS		EDAPHIC HABITATS
Proximity to water		TYPES				CHARACTERISTICS						TYPES					CLASSES, by size of rock (diameter)										
						Opening size (diameter)			Depth (horizontal)																		
<0.4 km	>0.4 km	Shallow caves	Cliff-face caves	Lava tubes	Mine shafts	<0.3 m	0.3–1 m	>1 m	<10 dm	10–30 dm	>30 dm	Cliff talus	Lava stringers	Collapsed lava tubes	Mine tailings	Roadside talus	I	II	III	IV	Old	New	Stabilized	Active	Alkaline	Fresh	
x	x	R	R	R	R	r			r	r		f	f	f	f	f	x	x	x	x	x		x			f	
x	x																										
x	x	RFO	RFO	RFO	RFO		x	x	x	x	x	f	f	f	f	f	x	x	x	x	f		f			f	
x	x	fo	fo	fo	fo	x	x	x	x	x	x	f	f	f	f	f	x	x	x	x	f		f			f	
x	x	fo	fo	fo	fo	x	x	x	x	x	x	fo	fo	fo	fo	fo	x	x	x	x	f		f			f	f
												fo	fo	fo	fo	fo	x	x	x	x	f		f				
												f	f	f	f	f	x	x	x	x			rfo			fo	
x	x	fo	fo	fo	fo	x	x	x	x	x	x	fo	fo	fo	fo	fo	x	x	x	x	f		f			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	f	f	f	f	f	f	f
x	x											fo	fo	fo	fo	fo	x	x	x	x	f	f	f	f	f	f	f
x	x											f	f	f	f	f	x	x	x	x	f	f	f	f	f	f	
x	x											f	f	f	f	f	x	x	x	x	f	f	f	f	f	f	
x	x		x			x			x	x		f	f	f	f	f	x	x	x	x	f	f	f	f	f	f	
x																					f		f			f	
x																					f		f			f	
x																					f		f			f	
x																					f		f			f	
x																					f		f			f	
x																					f		f			f	
x																					f		f			f	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			x	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			x	
x												fo					x	x	x	x	x		x			fo	
x	x	rfo	rfo	rfo	rfo		x	x	x	x	x																
x												fo					x	x	x	x	x		x			fo	
x												fo					x	x	x	x	x		x			fo	
x												fo															
x												fo					x	x	x	x	x		x			fo	
x												fo					x	x	x	x	x		x			fo	
x												fo					x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	f
x												fo														f	
x												fo														f	
x												fo														f	
x												fo														f	
X	X											fo	fo	fo	fo	fo	x	x	x	x					FO	FO	
X	X											fo	fo	fo	fo	fo	x	x	x	x					FO	FO	
x												fo					x	x	x	x							
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			f	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			f	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			f	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x	x											f	f	f	f	f	x	x	x	x	x		x		f	f	
x	x											fo	fo	fo	fo		x	x	x	x	x		x			f	
x												fo	fo	fo			x	x	x	x	x					fo	
x												fo	fo	fo			x	x	x	x	x					fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x		x	fo	
x												x					x	x	x	x							
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x							
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x							
																										rfo	
x	x											x	x	x	x	x	x	x	x	x							
x	x											RFO	RFO	RFO	RFO	RFO	x	x	x	x							
x												fo	fo	fo	fo	fo	x	x	x	x							
x												fo	fo	fo	fo	fo	x	x	x	x	x		x				
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x				
x																										fo	
x																										fo	
x												rfo					x	x	x	x							

Appendix 1 (continued)

Generalized Response of Terrestrial Species of Vertebrate Wildlife to Geomorphic and Edaphic Habitats

Legend: r = reproduction; f = feeding; o = other (cover, travel, observation, etc.); x = use; CAPITALS = "essential habitat" for the species

WILDLIFE SPECIES	FEATURES					CLIFFS																			
						STRUCTURAL CHARACTERISTICS																			
						Height class				Length class					Joint spacing (between joints)					Joint width (opening)				
	Caves	Rock shelters	Loose slabs	Ledges	Fissures	<3 m	3–10 m	10–30 m	>30 m	<30 m	30–100 m	100–500 m	500–1 500 m	>1 500 m	>30 m	7.5–30 m	1.5–7.5 m	0.3–1.5 m	<0.3 m	<0.15 m	0.15–0.30 m	0.3–0.6 m	0.6–1.5 m	>1.5 m
Swainson's thrush			rfo	rfo	rfo	x	x	x	x	x	x	x	x	x											
veery																									
western bluebird		rfo	rfo	rfo	rfo		x	x	x	x	x	x	x	x						x	x	x			
mountain bluebird		rfo	rfo	rfo	rfo		x	x	x	x	x	x	x	x						x	x	x			
Townsend's solitaire				fo		x	x	x	x	x	x	x	x	x											
blue-gray gnatcatcher				fo		x	x	x	x	x	x	x	x	x											
water pipit				fo			x	x	x	x	x	x	x	x											
Bohemian waxwing				o			x	x	x	x	x	x	x	x											
cedar waxwing				fo			x	x	x	x	x	x	x	x											
northern shrike			fo	fo	fo		x	x	x	x	x	x	x	x								x	x	x
loggerhead shrike			fo	fo	fo		x	x	x	x	x	x	x	x								x	x	x
European starling	rfo	rfo	rfo	rfo	rfo		x	x	x	x	x	x	x	x								x	x	x
solitary vireo																									
red-eyed vireo																									
warbling vireo																									
orange-crowned warbler																									
yellow warbler																									
yellow-rumped warbler																									
black-throated gray warbler																									
Townsend's warbler																									
ovenbird																									
MacGillivray's warbler																									
common yellowthroat																									
yellow-breasted chat																									
Wilson's warbler																									
American redstart																									
house sparrow	ro	ro	ro	ro	ro		x	x	x	x	x	x	x	x											
bobolink																									
western meadowlark				fo		x	x	x	x	x	x	x	x	x											
yellow-headed blackbird				o		x	x	x	x	x	x	x	x	x											
red-winged blackbird				o		x	x	x	x	x	x	x	x	x											
northern oriole																									
Brewer's blackbird				o		x	x	x	x	x	x	x	x	x											
brown-headed cowbird				o		x	x	x	x	x	x	x	x	x											
western tanager																									
rose-breasted grosbeak																									
black-headed grosbeak																									
indigo bunting																									
lazuli bunting																									
evening grosbeak																									
purple finch																									
Cassin's finch																									
house finch	ro		ro	ro	ro		x	x	x	x	x	x	x	x											
common redpoll				fo		x	x	x	x	x	x	x	x	x											
pine siskin																									
American goldfinch				fo		x	x	x	x	x	x	x	x	x											
lesser goldfinch				fo		x	x	x	x	x	x	x	x	x											
green-tailed towhee		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x
rufous-sided towhee		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x
savannah sparrow				fo		x	x			x	x	x	x	x											
grasshopper sparrow				fo		x	x			x	x	x	x	x											
vesper sparrow				fo		x	x			x	x	x	x	x											
lark sparrow				fo		x	x	x	x	x	x	x	x	x											
sage sparrow				fo		x	x	x	x	x	x	x	x	x											
northern junco		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
American tree sparrow		fo	fo	fo	fo	x	x	x	x	x	x	x	x	x											
chipping sparrow		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Brewer's sparrow		fo	fo	fo		x	x	x	x	x	x	x	x	x											
white-crowned sparrow		fo	fo	fo		x	x	x	x	x	x	x	x	x											
golden-crowned sparrow		fo	fo	fo		x	x	x	x	x	x	x	x	x											
fox sparrow				fo		x	x	x	x	x	x	x	x	x											
Lincoln's sparrow				fo		x	x	x	x	x	x	x	x	x											
song sparrow		rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lapland longspur		fo		fo		x	x	x	x	x	x	x	x	x											
snow bunting		fo		fo		x	x	x	x	x	x	x	x	x											

ASSOCIATIONS		CAVES										TALUS									LAVA FLOWS		SAND DUNES		PLAYAS		EDAPHIC HABITATS
Proximity to water		TYPES				CHARACTERISTICS: Opening size (diameter)			CHARACTERISTICS: Depth (horizontal)			TYPES					CLASSES, by size of rock (diameter)										
<0.4 km	>0.4 km	Shallow caves	Cliff-face caves	Lava tubes	Mine shafts	<0.3 m	0.3–1 m	>1 m	<10 dm	10–30 dm	>30 dm	Cliff talus	Lava stringers	Collapsed lava tubes	Mine tailings	Roadside talus	I	II	III	IV	Old	New	Stabilized	Active	Alkaline	Fresh	
x												rfo					x	x	x	x							
x																											
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x							
x	x																									fo	
x	x																									fo	
x	x																									fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x	x																										
x		ro	ro			x			x	x																f	
																										fo	
																										fo	
																										fo	
																										fo	
x	x																				rfo		rfo			fo	
x																										fo	
x																										fo	
x																										fo	
x																										fo	
																										fo	
																										fo	
																										fo	
																										fo	
																										fo	
																										fo	
																										fo	
																										fo	
r	o																									fo	
x	x																				x		x			x	
x																					f		f			fo	
x																					f		f			fo	
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x						fo	
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												fo	fo	fo	fo	fo	x	x	x	x	x		x			fo	
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			fo	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			f	
x	x											fo	fo	fo	fo	fo	x	x	x	x	x		x			f	

Appendix 1 (continued)

Generalized Response of Terrestrial Species of Vertebrate Wildlife to Geomorphic and Edaphic Habitats

Legend: r = reproduction; f = feeding; o = other (cover, travel, observation, etc.); x = use; CAPITALS = "essential habitat" for the species

WILDLIFE SPECIES	FEATURES					CLIFFS																		
						STRUCTURAL CHARACTERISTICS																		
						Height class				Length class					Joint spacing (between joints)					Joint width (opening)				
	Caves	Rock shelters	Loose slabs	Ledges	Fissures	<3 m	3–10 m	10–30 m	>30 m	<30 m	30–100 m	100–500 m	500–1 500 m	>1 500 m	>30 m	7.5–30 m	1.5–7.5 m	0.3–1.5 m	<0.3 m	<0.15 m	0.15–0.30 m	0.3–0.6 m	0.6–1.5 m	>1.5 m
Mammals																								
Malheur shrew																								
wandering shrew																								
Merriam shrew																								
little brown myotis	RO	RO	RO	RO	RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Yuma myotis																								
long-eared myotis																								
fringed myotis																								
long-legged myotis																								
California myotis	RO	RO	RO		RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
small-footed myotis	RO	RO	RO		RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
silver-haired bat																								
western pipistrelle	RO	RO	RO		RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
big brown bat	RO	RO	RO		RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
hoary bat																								
spotted bat	RO	RO	RO		RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
western big-eared bat	RO						x	x	x	x	x	x	x	x										
pallid bat	RO	RO	RO		RO		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
pygmy rabbit																								
mountain cottontail																								
white-tailed jackrabbit																								
black-tailed jackrabbit																								
least chipmunk	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
yellow-pine chipmunk	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
yellow-bellied marmot		RFO	RFO	RFO	RFO	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
antelope ground squirrel																								
Townsend ground squirrel																								
Richardson ground squirrel																								
Belding ground squirrel																								
mantled ground squirrel			RFO	RFO	RFO	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		
Townsend pocket gopher																								
northern pocket gopher																								
little pocket mouse																								
Great Basin pocket mouse																								
dark kangaroo mouse																								
Ord kangaroo rat																								
chisel-toothed kangaroo rat																								
beaver																								
western harvest mouse		rfo	rfo		rfo	x	x	x	x	x	x	x	x	x						x				
canyon mouse	RFO	RFO	RFO	RFO	RFO		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
deer mouse	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
northern grasshopper mouse																								
desert woodrat																								
bushy-tailed woodrat	RFO	RFO	RFO	RFO	RFO	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
montane vole																								
long-tailed vole																								
sage vole																								
muskrat																								
western jumping mouse																								
porcupine	rfo	rfo	rfo	rfo	rfo	x	x			x	x	x	x	x								x	x	x
coyote	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x								x	x	x
red fox	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x								x	x	x
kit fox	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x								x	x	x
raccoon	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x								x	x	x
long-tailed weasel	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x						x	x	x		
mink	rfo	rfo	rfo	rfo	rfo	x	x	x		x	x	x	x	x							x	x	x	x
badger	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x								x	x	x
spotted skunk	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x							x	x	x	x
striped skunk	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x								x	x	x
river otter	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x								x	x	x
cougar	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x									x	x
bobcat	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x								x	x	x
mule deer		o		f		x	x	x	x	x	x	x	x	x										
pronghorn																								
bighorn sheep	rfo	rfo		rfo			x	x	x	x	x	x	x	x										

ASSOCIATIONS		CAVES										TALUS									LAVA FLOWS		SAND DUNES		PLAYAS		EDAPHIC HABITATS
Proximity to water		TYPES				CHARACTERISTICS						TYPES					CLASSES, by size of rock (diameter)										
						Opening size (diameter)			Depth (horizontal)																		
<0.4 km	>0.4 km	Shallow caves	Cliff-face caves	Lava tubes	Mine shafts	<0.3 m	0.3–1 m	>1 m	<10 dm	10–30 dm	>30 dm	Cliff talus	Lava stringers	Collapsed lava tubes	Mine tailings	Roadside talus	I	II	III	IV	Old	New	Stabilized	Active	Alkaline	Fresh	
X		RO	RO	RO	RO	x	x	x	x	x	x	fo	fo	fo	fo	fo	f	f	f		f	f				f	
X																										fo	
X																										fo	
X																										fo	
X																										fo	
X		RO	RO	RO	RO	x	x	x	x	x	x						f	f	f		f	f				f	
X		RO	RO	RO	RO	x	x	x	x	x	x	f	f	f	f	f	f	f	f	f	f	f				f	
X																										fo	
X		RO	RO	RO	RO	x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	f	f	f	f	f	f				fo	
X		RO	RO	RO	RO	x	x	x	x	x	x	f	f	f	f	f	f	f	f	f	f	f				fo	
X																										fo	
X																										fo	
X			RO	RO		x	x	x		x	x	fo	fo	fo	fo	fo	f	f	f	f	f	f				fo	
X		RO	RO	RO		x	x	x		x	x	fo	fo	fo	fo	fo	f	f	f	f	f	f				fo	
x	x											rfo	rfo	rfo			x	x	x				RFO				
x												RFO	RFO	RFO	RFO	RFO	x	x	x		rfo	rfo	x				
x	x											x	x	x	x	x	x	x			x		RFO			fo	x
x	x											x	x	x	x	x	x	x			x		RFO			fo	x
x	x	rfo	rfo	rfo	rfo	x	x	x	x	x		rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x			x	
x	x	rfo	rfo	rfo	rfo	x	x	x	x	x		rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x			x	
x												RFO	RFO	RFO	RFO	RFO	x	x			RFO	RFO				fo	
																											RFO
x	x																									rfo	
x	x																									rfo	
x																										rfo	
x	x											RFO	RFO	RFO	RFO	RFO	x	x	x		x					x	
												rfo	rfo	rfo	rfo	rfo	x	x	x	x	x					fo	
																							RFO	x			x
																							rfo	x			x
																							rfo	x			
X																											
x		rfo				x			x			rfo	rfo	rfo	rfo	rfo			x	x						rfo	
x	x	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						
x	x	rfo	rfo	rfo	rfo	x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x
x												rfo	rfo	rfo	rfo	rfo	x	x	x	x						rfo	
x	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x			
x	x	rfo	rfo	rfo	rfo	x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	
X																											
x																										rfo	
	x											rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x		x	
X																											
X																										rfo	
x	x	rfo					x	x	x	x	x	rfo	rfo	rfo	rfo	rfo			x	x	x	x	x			x	
x	x	rfo		rfo	rfo		x	x		x	x	rfo	rfo	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x
x		rfo	rfo	rfo	rfo	x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			x	
x	x	rfo				x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		RFO	RFO		x	x
X		rfo	rfo	rfo	rfo		x	x		x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			x	x
x	x	rfo	rfo	rfo	rfo	x			x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x	x	x	x	x	x	x
X		rfo	rfo	rfo	rfo	x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x			x	
x	x	rfo		rfo	rfo		x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x	x			
x	x	rfo		rfo	rfo	x	x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x	x		x				
x		rfo		rfo	rfo		x	x	x	x	x	rfo	rfo	rfo	rfo	rfo	x	x	x	x						x	
X		rfo					x	x		x	x	rfo					x	x	x	x							
x	x	rfo	rfo	rfo	rfo		x	x		x	x	rfo	rfo	rfo			x	x	x	x	x		x			x	
x	x	rfo	rfo	rfo	rfo		x	x		x	x	rfo	rfo	rfo			x	x	x	x	x	x	x	x	x	x	x
x	x											rfo	rfo	fo			x	x	x	x	x		x			x	x
x	x																						x			x	x
x	x	rfo	rfo					x		x	x	rfo	rfo				x	x	x	x	x						

Appendix 2

Common and Scientific Names of Wildlife and References Used To Construct Appendix 1

Order, family, and common name	Scientific name	Reference
	AMPHIBIANS	
Caudata:		Stebbins 1951, 1966
Ambystomidae— long-toed salamander	*Ambystoma macrodactylum*	Anderson 1967, 1968; Farner and Kezer 1955
Anura:		Wright and Wright 1949
Pelobatidae— Great Basin spadefoot	*Scaphiopus intermontanus*	Bragg 1945, Mayhew 1965, Wasserman 1958
Bufonidae— western toad	*Bufo boreas*	Campbell 1970, Clarke 1974a, Lillywhite et al. 1973
Woodhouse toad	*Bufo woodhousei*	Bragg 1940, Clarke 1974b, Thornton 1960
Hylidae— Pacific treefrog	*Hyla regilla*	Brown 1975, Jameson 1956, Jameson et al. 1970
Ranidae— spotted frog	*Rana pretiosa*	Hollenbeck 1974, Licht 1975, Turner 1960
leopard frog	*Rana pipiens*	Hine et al. 1975, Pace 1974, Ruibal 1962
bullfrog	*Rana catesbeiana*	Darham and Bennett 1963, Sebetich 1969, Wiewandt 1969
	REPTILES	
Squamata:		Ditmars 1936, Schmidt and Davis 1941, Stebbins 1954, 1966, Wright and Wright 1957
Iguanidae— collared lizard	*Crotaphytus collaris*	Fitch 1956, Storm 1966, Talley[1]
leopard lizard	*Crotaphytus wislizeni*	Parker and Pianka 1976, Tanner and Krogh 1974
western fence lizard	*Sceloporus occidentalis*	Davis and Verbeek 1972, Marcellini and Mackey 1970, Rose 1976
sagebrush lizard	*Sceloporus graciosus*	Derickson 1976, Tinkle 1973, Woodbury and Woodbury 1945
side-blotched lizard	*Uta stansburiana*	Parker 1974a, Parker and Pianka 1975, Tinkle 1967
desert horned lizard	*Phrynosoma platyrhinos*	Clark and Comanor 1976, Pianka and Parker 1975, Tanner and Krogh 1973

[1]Talley, Pamela S. 1974. Report on lizard studies. Unpublished report on file at Vale District, U.S. Dep. Inter., Bur. Land Manage., Vale, Oreg.

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
short-horned lizard	*Phrynosoma douglassi*	Goldberg 1971, Heath 1965, Reeve 1952
Scincidae— western skink	*Eumeces skiltonianus*	Maser[2]
Teiidae— western whiptail	*Cnemidophorus tigris*	Apslund 1974, Burkholder and Walker 1973, Parkes 1972, Pianka 1970, Vitt and Ohmart 1977
Boidae— rubber boa	*Charina bottae*	Schmidt and Davis 1941 Peabody et al. 1975
Colubridae— yellow-bellied racer	*Coluber constrictor*	Brown and Parker 1976, Fitch 1963, Herzog and Burghardt 1974
striped whipsnake	*Masticophis taeniatus*	Parker 1974b, 1976
gopher snake	*Pituophis melanoleucus*	Bogert and Roth 1966, Greenwald 1974, Stull 1940
common garter snake	*Thamnophis sirtalis*	Aleksiuk 1977, Carpenter 1952, Fitch 1965
wandering garter snake	*Thamnophis elegans*	Fox 1948, 1951
western ground snake	*Sonora semiannulata*	Talley,[3] Staedeli 1964, Stickel 1943
night snake	*Hypsiglena torquata*	Clark and Lieb 1973
Viperidae— western rattlesnake	*Crotalus viridis*	Klauber 1972, Parker and Brown 1974, Rahn 1942
	BIRDS	
		American Ornithologists' Union 1957, 1973a, 1973b, 1976; Bent 1926, 1961a, 1961b, 1962a, 1962b, 1962c, 1962d, 1963a, 1963b, 1963c, 1963d, 1963e, 1964a, 1964b, 1964c, 1964d, 1964e, 1964f, 1964g, 1965a, 1965b, 1968a, 1968b, 1968c; Bertrand and Scott 1973; Craighead and Craighead 1969; Gabrielson and Jewett 1970; Jackman 1974; Olendorff and Stoddart 1974; Peterson 1961; Preston and Norris 1947; Reeves 1975
Gaviiformes:		Scott et al. 1972
Gaviidae— common loon	*Gavia immer*	McIntyre 1975, 1978; Olson and Marshall 1952

[2]Maser, Chris. 1975-77. Unpublished data on file at Puget Sound Museum of Natural History, Univ. Puget Sound, Tacoma, Wash.

[3]Talley, Pam. [n.d.] Western ground snake, *Sonora semiannulata*. 11 p. Unpublished report on file at Vale District, U.S. Dep. Inter., Bur. Land Manage., Vale, Oreg.

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
Podicipediformes:		
Podicipedidae—		
red-necked grebe	*Podiceps grisegena*	Kebbe 1958, Kiss and Sterbetz 1973, Spahn 1978
horned grebe	*Podiceps auritus*	Faaborg 1976; Fjeldsa 1973a, 1973b; Sugden 1977
eared grebe	*Podiceps nigricollis*	Faaborg 1976; McAllister 1955, 1963; Storer et al. 1976
western grebe	*Aechmophorus occidentalis*	Feerer and Garrett 1977, Lawrence 1950, Nuechterlein 1975
pied-billed grebe	*Podilymbus podiceps*	Faaborg 1976, Glover 1953, Kirby 1976, Sealy 1978b
Pelecaniformes:		
Pelecanidae—		
American white pelican	*Pelecanus erythrorhynchos*	Johnson and Sloan 1978, Knopf 1975, Sloan 1973
Phalacrocoracidae—		
double-crested cormorant	*Phalacrocorax auritus*	Ellison and Cleary 1978, Lack 1945, Van Tets 1959
Ciconiiformes:		
Ardeidae—		
great blue heron	*Ardea herodias*	Henny and Bethers 1971, Jenni 1969, Krebs 1974, Meyerriecks 1960, Nehls 1972
green heron	*Butorides striatus*	Kushlan 1976
common egret	*Casmerodius albus*	Pratt 1970
cattle egret	*Bubulcus ibis*	Blaker 1969, Burger 1978, Curry-Lindahl 1971
black-crowned night heron	*Nycticorax nycticorax*	Allen and Mangels 1938-39, Hoffman and Prince 1975, Nickell 1966, Wolford and Boag 1971
American bittern	*Botaurus lentiginosus*	Duebbert and Lokemoen 1977
least bittern	*Ixobrychus exilis*	Weller 1961
Threskiornithidae—		
white-faced ibis	*Plegadis chihi*	Burger and Miller 1977, Ryder 1967b
Anseriformes:		Harris 1952
Anatidae—		
whistling swan	*Olor columbianus*	Scott 1977, Sherwood 1960
Canada goose	*Branta canadensis*	Jarvis and Harris 1967, Martin 1964
white-fronted goose	*Anser albifrons*	Mickelson 1975
snow goose	*Chen caerulescens*	Cooch 1958, Dzubin et al. 1975, Kerbes 1975

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
Ross' goose	*Chen rossii*	Barry 1964; Ryder 1967a, 1972
mallard	*Anas platyrhynchos*	Anderson and Henny 1972, Anderson et al. 1974, Martin and Carney 1977, Pospahala et al. 1974
gadwall	*Anas strepera*	Gates 1962, Jensen 1949, Serie and Swanson 1976
common pintail	*Anas acuta*	Fuller 1953, Krapu 1977, Rundquist 1973, Smith 1970
green-winged teal	*Anas crecca*	Bennett and Bolen 1978, Moisan 1966
blue-winged teal	*Anas discors*	Swanson and Meyer 1977, Swanson et al. 1974, Wheeler 1965
cinnamon teal	*Anas cyanoptera*	Connelly 1978, Spencer 1953
American wigeon	*Anas americana*	Gates 1958, 1962
northern shoveler	*Anas clypeata*	Girard 1939, March 1967, Poston 1974
wood duck	*Aix sponsa*	Gilmer et al. 1978, McGilvrey 1968, Wildlife Management Institute 1966
redhead	*Aythya americana*	McKnight 1974, Michot 1976, Weller 1964
ring-necked duck	*Aythya collaris*	Marshall and Duebbert 1965, Mendall 1958
canvasback	*Aythya valisineria*	Erickson 1948, Hochbaum 1944, Olson 1964, Sugden 1978
greater scaup	*Aythya marila*	Gehrman 1951
lesser scaup	*Aythya affinis*	Bartonek and Hickey 1969, Himes 1977, Rogers 1962
common goldeneye	*Bucephala clangula*	Gibbs 1961, McLaren 1962, Munro 1939
Barrow's goldeneye	*Bucephala islandica*	Griffee 1958, Munro 1939, Myres 1957
bufflehead	*Bucephala albeola*	Erskine 1960, 1961; Griffee 1961a; Munro 1942
King eider	*Somateria spectabilis*	
oldsquaw	*Clangula hyemalis*	Ellarson 1956, Rofritz 1977
ruddy duck	*Oxyura jamaicensis*	McKnight 1974, Misterek 1974, Siegfried 1977
hooded merganser	*Lophodytes cucullatus*	Griffee 1954, Kitchen 1968, Morse et al. 1969
common merganser	*Mergus merganser*	Erskine 1972, Miller and Barclay 1974
red-breasted merganser	*Mergus serrator*	Lingle and Schupbach 1977

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
Falconiformes:		Brown and Amadon 1968, Craighead and Craighead 1969
Cathartidae— turkey vulture	*Cathartes aura*	Coles 1938, Jackson et al. 1978, Stewart 1977
Accipitridae— northern goshawk	*Accipiter gentilis*	Anderson,[4] Reynolds 1978, Reynolds and Wight 1978
sharp-shinned hawk	*Accipiter striatus*	Brown 1973, Platt 1973
Cooper's hawk	*Accipiter cooperii*	Henny and Wight 1972, Meng 1952
red-tailed hawk	*Buteo jamaicensis*	Fitch et al. 1946, Gates 1972, Luttich et al. 1970
Swainson's hawk	*Buteo swainsoni*	Dunkle 1977, Fitzner 1978, Olendorff 1972
rough-legged hawk	*Buteo lagopus*	Schnell 1968, Springer 1975
ferruginous hawk	*Buteo regalis*	Wakeley 1974, Weston 1969, Wolffinden 1975
golden eagle	*Aquila chrysaetos*	Beecham and Kochert 1975, McGahan 1968, Mosher and White 1976, Murphy et al. 1969, Seibert et al. 1976, Snow 1973a
bald eagle	*Haliaeetus leucocephalus*	Mathisen et al. 1977, Murphy 1977, Platt 1976, Snow 1973b, Steenhoff 1978
northern harrier	*Circus cyaneus*	Clark and Ward 1974, Duebbert and Lokemoen 1977, Hamerstrom 1969
Pandionidae— osprey	*Pandion haliaetus*	Henny 1977, Henny et al. 1978, Melquist et al. 1978, Zarn 1974a
Falconidae— prairie falcon	*Falco mexicanus*	Denton 1976, Ogden and Hornocker 1977, Parker 1973, Snow 1974a
peregrine	*Falco peregrinus*	Hickey 1969, Porter and White 1973, Snow 1972
merlin	*Falco columbarius*	Fox 1971, Hodson 1976, Trimble 1975a
American kestrel	*Falco sparverius*	Enderson 1960, Henny et al.,[5] Smith et al. 1972
Galliformes:		
Tetraonidae— blue grouse	*Dendragapus obscurus*	Bendell and Elliott 1967, Donaldson and Bergerud 1974, Severson 1978, Weber et al. 1974

[4]Anderson, Ralph G. Goshawks and forest management in northeast Oregon. Unpublished data on file at U.S. Dep. Agric., Forest Service, Bear Sled Ranger District, Wallowa, Oreg. 97885.

[5]Henny, Charles J., Morlan W. Nelson, and Stephen R. Gray. 1976. Impact of 1974 DDT spraying for tussock moth control on American kestrels. 23 p. Report to USDA For. Serv., Pac. Northwest Reg., Portland, Oreg.

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
ruffed grouse	*Bonasa umbellus*	Bump et al. 1947, Moulton and Vanderschaegen 1974, Robertson 1976
sage grouse	*Centrocercus urophasianus*	Braun et al. 1977, Gray 1967, Wallestad 1975
Phasianidae—		
California quail	*Lophortyx californicus*	Anthony 1970, Storer et al. 1942, Sumner 1935
mountain quail	*Oreortyx pictus*	Gutierrez 1975, Lahnum 1944, Ormiston 1966
chukar	*Alectoris chukar*	Galbreath and Moreland 1953, Mackie and Buechner 1963, Molini 1976
gray partridge	*Perdix perdix*	McKinney 1966, Weigand 1977, Westerskov 1949
ring-necked pheasant	*Phasianus colchicus*	Allen 1956, Crouse 1941, Olsen 1977
Gruiformes:		
Gruidae—		
sandhill crane	*Grus canadensis*	Drewien and Bizeau 1974, Mullins and Bizeau 1978, Walkinshaw 1949
Rallidae—		
Virginia rail	*Rallus limicola*	Billard 1947, Glahn 1974, Horak 1964, Reeves 1975
sora	*Porzana carolina*	Billard 1947, Glahn 1974, Horak 1964, Reeves 1975
American coot	*Fulica americana*	Crawford 1977, Frederickson 1970, Jahn 1965, Jones 1940
Charadriiformes:		
Charadriidae—		
semi-palmated plover	*Charadrius semipalmatus*	Stout 1967 Gerstenberg and Jurek 1972
snowy plover	*Charadrius alexandrinus*	Oregon Department of Fish and Wildlife 1977, Purdue 1974
killdeer	*Charadrius vociferus*	Bunni 1959, Lenington and Mace 1975, Mace 1978
mountain plover	*Charadrius montanus*	Graul 1975, Laun 1957
Scolopacidae—		
common snipe	*Capella gallinago*	Gerstenberg and Jurek 1972 Reeves 1975, Tuck 1972, Winegardner 1976
long-billed curlew	*Numenius americanus*	Bicak 1977, Bucher 1978, McCallum et al. 1977, Sadler and Maher 1976
spotted sandpiper	*Actitis macularia*	Nelson 1939
solitary sandpiper	*Tringa solitaria*	
greater yellowlegs	*Tringa melanoleuca*	

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
lesser yellowlegs	*Tringa flavipes*	
willet	*Catoptrophorus semipalmatus*	
pectoral sandpiper	*Calidris melanotos*	Pitelka 1959
Baird's sandpiper	*Calidris bairdii*	
least sandpiper	*Calidris minutilla*	
western sandpiper	*Calidris mauri*	
long-billed dowitcher	*Limnodromus scolopaceus*	
marbled godwit	*Limosa fedoa*	
Recurvirostridae—		Gerstenberg and Jurek 1972, Wetmore 1925
American avocet	*Recurvirostra americana*	Bucher 1978, Gibson 1971
black-necked stilt	*Himantopus mexicanus*	
Phalaropodidae—		Wetmore 1925
Wilson's phalarope	*Steganopus tricolor*	Burger and Howe 1975, Hohn 1967, Johns 1969
northern phalarope	*Lobipes lobatus*	Cole 1943, Hohn 1971, Tinbergen 1935
Laridae—		
herring gull	*Larus argentatus*	Hunt 1972
California gull	*Larus californicus*	Greenhalgh 1952, Vermeer 1970
ring-billed gull	*Larus delawarensis*	Broadbooks 1961, Miller and Emlen 1975, Vermeer 1970
Franklin's gull	*Larus pipixcan*	Burger 1974, Jewett 1949
Bonaparte's gull	*Larus philadelphia*	
Forster's tern	*Sterna forsteri*	McNicholl 1971, Salt and Willard 1971, Storey 1977
Caspian tern	*Sterna caspia*	
black tern	*Chlidonias niger*	Einarsen 1941
Columbiformes:		
Columbidae—		
rock dove	*Columba livia*	Kindschy 1964; Murton et al. 1972, 1974
mourning dove	*Zenaida macroura*	Dolton 1977, Miles 1976, Ruos and Dolton 1977, U.S. Department of the Interior Fish and Wildlife Service 1962
Cuculiformes:		Trimble 1975b
Cuculidae—		
yellow-billed cuckoo	*Coccyzus americanus*	Quaintance 1944

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
Strigiformes:		Burton 1973, Craighead and Craighead 1969
Tytonidae—		
barn owl	*Tyto alba*	Henny 1969, Rudolph 1978, Smith and Marti 1976, Smith et al. 1974, Stewart 1952
Strigidae—		
common screech owl	*Otus asio*	Nowicki 1974, Smith and Wilson 1971, VanCamp and Henny 1975
flammulated owl	*Otus flammeolus*	Balda et al. 1975, Marshall 1939, Winter 1974
great horned owl	*Bubo virginianus*	Baumgartner 1939, Rusch et al. 1972, Stewart 1969
pygmy owl	*Glaucidium gnoma*	Burton 1973
burrowing owl	*Athene cunicularia*	Collins and Landry 1977, Maser et al. 1971, Zarn 1974b
long-eared owl	*Asio otus*	Glue 1977, Maser et al. 1970, Sonnenberg and Powers 1976
short-eared owl	*Asio flammeus*	Banfield 1947, Clark 1975, Marti 1974
saw-whet owl	*Aegolius acadicus*	Forbes and Warner 1974, Kebbe 1959, Woods 1972
Caprimulgiformes:		Trimble 1975b
Caprimulgidae—		
poorwill	*Phalaenoptilus nuttallii*	Horn and Marshall 1975
common nighthawk	*Chordeiles minor*	Armstrong 1965, Dexter 1961, Rust 1947, Selander 1954
Apodiformes:		Trimble 1975b
Apodidae—		
black swift	*Cypseloides niger*	
Vaux's swift	*Chaetura vauxi*	Baldwin and Hunter 1963, Baldwin and Zaczkowski 1963, Griffee 1961b, Thompson 1977
white-throated swift	*Aeronautes saxatalis*	Weber 1975
Trochilidae—		Greenwalt 1960
black-chinned hummingbird	*Archilochus alexandri*	
broad-tailed hummingbird	*Selasphorus platycercus*	Calder 1973, Calder and Booser 1973, Lyon 1973
rufous hummingbird	*Selasphorus rufus*	Gass et al. 1976, Horvath 1964
calliope hummingbird	*Stellula calliope*	Calder 1971, 1973
Anna's hummingbird	*Calypte anna*	Pitelka 1951b, Stiles 1971, Stiles and Wolf 1973

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
Coraciiformes:		Trimble 1975b
Alcedinidae—		
belted kingfisher	*Megaceryle alcyon*	Hamas 1974, Kilham 1974
Piciformes:		
Picidae—		Conner 1973, Conner et al. 1975, 1976, Jackman 1974
common flicker	*Colaptes auratus*	Anderson 1972, Conner 1973
yellow-bellied sapsucker	*Sphyrapicus varius*	Erskine and McLaren 1972, Kilham 1971a, Lawrence 1967
Williamson's sapsucker	*Sphyrapicus thyroideus*	Crockett and Hansley 1977, Michael 1936
Lewis' woodpecker	*Picoides lewis*	Bock 1970, Bock et al. 1971
hairy woodpecker	*Picoides villosus*	Kilham 1968a, Lawrence 1967, Staebler 1949
downy woodpecker	*Picoides pubescens*	Jackson 1970, Lawrence 1967, Staebler 1949
white-headed woodpecker	*Picoides albolarvatus*	Ligon 1973
Passeriformes:		Verner and Wilson 1969
Tyrannidae—		Trimble 1975b
eastern kingbird	*Tyrannus tyrannus*	Dick and Rising 1965, Hespenheide 1964, Morehouse and Brewer 1968
western kingbird	*Tyrannus verticalis*	Dick and Rising 1965, Ohlendorf 1974
ash-throated flycatcher	*Myiarchus cinerascens*	
Say's phoebe	*Sayornis saya*	Ohlendorf 1976, Whitaker 1974
willow flycatcher	*Empidonax traillii*	Aldrich 1955, King 1955, Robbins 1974
Hammond's flycatcher	*Empidonax hammondii*	Beaver and Baldwin 1975, Davis 1954, Manuwal 1970
gray flycatcher	*Empidonax wrightii*	Johnson 1963, Lavers 1975, Russell and Woodbury 1941
western flycatcher	*Empidonax difficilis*	Brodkorb 1949, Davis et al. 1963
western wood pewee	*Contopus sordidulus*	
olive-sided flycatcher	*Nuttallornis borealis*	
Alaudidae—		
horned lark	*Eremophila alpestris*	Beason and Franks 1974, Pickwell 1931, Verbeek 1967
Hirundinidae—		Trimble 1975b
violet-green swallow	*Tachycineta thalassina*	Combellack 1954
tree swallow	*Iridoprocne bicolor*	Chapman 1935, Kuerzi 1940-41
bank swallow	*Riparia riparia*	Freer 1977, Petersen 1955, Stoner 1936

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
rough-winged swallow	*Stelgidopteryx ruficollis*	Lunk 1962
barn swallow	*Hirundo rustica*	Henny 1972, Jackson and Burchfield 1975, Mason 1953
cliff swallow	*Petrochelidon pyrrhonota*	Buss 1942, Emlen 1952, Mayhew 1958
Corvidae—		Jollie 1976, Trimble 1975b, Turcek and Kelso 1968
gray jay	*Perisoreus canadensis*	Aldrich 1943, Ouellet 1970, Rutter 1969
Steller's jay	*Cyanocitta stelleri*	Brown 1963
scrub jay	*Aphelocoma coerulescens*	Pitelka 1951a
black-billed magpie	*Pica pica*	Bock and Lepthien 1975, Brown 1957, Erpino 1968, Jones 1960
northern raven	*Corvus corax*	Larsen and Dietrich 1970, Maser 1975, Montevecchi 1978
American crow	*Corvus brachyrhynchos*	Good 1952, Montevecchi 1976, Platt 1956
pinyon jay	*Gymnorhinus cyanocephalus*	Balda and Bateman 1971, Bateman and Balda 1973, Ligon and Martin 1974
Clark's nutcracker	*Nucifraga columbiana*	Giuntoli and Mewaldt 1978, Mewaldt 1956, Tomback 1977
Paridae—		Trimble 1975b
black-capped chickadee	*Parus atricapillus*	Henny 1972; Kessel 1976; Odum 1941a, 1941b; Sturman 1968
mountain chickadee	*Parus gambeli*	Dixon 1961, Kluyver 1961
bushtit	*Psaltriparus minimus*	Ervin 1977
Sittidae—		
white-breasted nuthatch	*Sitta carolinensis*	Kilham 1968b, 1971b, 1972
red-breasted nuthatch	*Sitta canadensis*	Anderson 1976, Kilham 1973, Stallcup 1968
Certhiidae—		
brown creeper	*Certhia familiaris*	Apfelbaum and Haney 1977, McClelland 1975, McClelland and Frissell 1975
Cinclidae—		
dipper	*Cinclus mexicanus*	Parsons 1975, Price and Bock, 1973, Thut 1970
Troglodytidae—		Trimble 1975b
house wren	*Troglodytes aedon*	Kendeigh 1941, Kroodsma 1973
winter wren	*Troglodytes troglodytes*	Armstrong 1956, Evenden 1950
marsh wren	*Cistothorus palustris*	Kale 1965; Verner 1963, 1975; Verner and Engelsen 1970

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
canyon wren	*Catherpes mexicanus*	Grinnell and Behle 1935
rock wren	*Salpinctes obsoletus*	Kroodsma 1975
Mimidae—		Trimble 1975b
gray catbird	*Dumetella carolinensis*	Fletcher and Smith 1978, Harcus 1973
brown thrasher	*Toxostoma rufum*	
sage thrasher	*Oreoscoptes montanus*	Reynolds and Rich 1978, Rich 1978b
Turdidae—		Trimble 1975b
American robin	*Turdus migratorius*	Farner 1949, Henny 1972, James and Shugart 1974
varied thrush	*Ixoreus naevius*	Martin 1970
hermit thrush	*Catharus guttatus*	Cochran et al. 1967, Morse 1972, Noon 1977
Swainson's thrush	*Catharus ustulatus*	Morse 1972, Noon 1977
veery	*Catharus fuscescens*	Aldrich 1939, Bertin 1977, Noon 1977
western bluebird	*Sialia mexicana*	Herlugson 1978, Pinkowski 1978
mountain bluebird	*Sialia currucoides*	Haecker 1948, Pinkowski 1978, Power 1966
Townsend's solitaire	*Myadestes townsendi*	Lederer 1977a, 1977b; Solomonson and Balda 1977
Sylviidae —		Trimble 1975b
blue-gray gnatcatcher	*Popioptila caerulea*	
ruby-crowned kinglet	*Regulus calendula*	
Motacillidae—		
water pipit	*Anthus spinoletta*	Gibb 1956, Verbeek 1970
Bombycillidae—		
Bohemian waxwing	*Bombycilla garrulus*	Bakke 1977, Knapton and Sexton 1978
cedar waxwing	*Bombycilla cedrorum*	Burleigh 1963, Gollob and Pulich 1978
Laniidae—		
northern shrike	*Lanius excubitor*	Cade 1962, 1967; Davis 1974
loggerhead shrike	*Lanius ludovicianus*	Craig 1978; Porter et al. 1975; Smith 1973a, 1973b
Sturnidae—		
European starling	*Sturnus vulgaris*	Bray et al. 1975, DeHaven and DeHaven 1973, Planck 1967
Vireonidae—		Chapin 1925, Trimble 1975b
solitary vireo	*Vireo solitarus*	Hamilton 1962; James 1973, 1976
red-eyed vireo	*Vireo olivaceus*	Lawrence 1953, Southern 1958, Williamson 1971

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
warbling vireo	*Vireo gilvus*	James 1976
Parulidae—		Griscom and Sprunt 1957, Trimble 1975b
orange-crowned warbler	*Vermivora celata*	Ficken and Ficken 1962a
Nashville warbler	*Vermivora ruficapilla*	Lawrence 1948, Roth 1977
yellow warbler	*Dendroica petechia*	Ficken and Ficken 1965, Morse 1973
yellow-rumped warbler	*Dendroica coronata*	Hubbard 1969
black-throated gray warbler	*Dendroica nigrescens*	
Townsend's warbler	*Dendroica townsendi*	
ovenbird	*Seiurus aurocapillus*	Littlefield and Mclaury 1975, Stenger 1958, Zach 1978
MacGillivray's warbler	*Oporornis tolmiei*	
common yellowthroat	*Geothlypis trichas*	Hofslund 1959, Wunderle 1978
yellow-breasted chat	*Icteria virens*	Ficken and Ficken 1962b, Stewart 1953, Thompson and Nolan 1973
Wilson's warbler	*Wilsonia pusilla*	Stewart et al. 1977
American redstart	*Setophaga ruticilla*	Ficken and Ficken 1967, McLaren 1975, Morse 1973
Ploceidae— house sparrow	*Passer domesticus*	Kendeigh 1973, Summers-Smith 1967, Summers-Smith and Pinowski 1968
Icteridae— bobolink	*Dolichonyx oryzivorus*	Martin 1974
western meadowlark	*Sturnella neglecta*	Anderson and Merrill 1967, Lanyon 1957
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Willson 1966, Willson and Orians 1963
red-winged blackbird	*Agelaius phoeniceus*	Cutright 1973, Dolbeer 1978, Krapu 1978, Robertson 1972
northern oriole	*Icterus galbula*	Pleasants 1977, Schaefer 1976
Brewer's blackbird	*Euphagus cyanocephalus*	Hansen and Carter 1963, Horn 1968, Stepney 1975
brown-headed cowbird	*Molothrus ater*	Friedmann 1963, Hill 1976, Payne 1976
Thraupidae— western tanager	*Piranga ludoviciana*	Trimble 1975b
Fringillidae—		Trimble 1975b
rose-breasted grosbeak	*Pheucticus ludovicianus*	Kroodsma 1974, Lemon and Chatfield 1973

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
black-headed grosbeak	*Pheucticus melanocephalus*	Kroodsma 1974
indigo bunting	*Passerina cyanea*	Emlen et al. 1975, Wells 1958, Whitmore 1975
lazuli bunting	*Passerina amoena*	Emlen et al. 1975, Thompson 1976, Whitmore 1975
evening grosbeak	*Hesperiphona vespertina*	Balph and Balph 1976, Blais and Parks 1964, Dexter 1975
purple finch	*Carpodacus purpureus*	Pulliam and Enders 1971
Cassin's finch	*Carpodacus cassinii*	Balph 1978, Herman 1971, Samson 1976
house finch	*Carpodacus mexicanus*	Thompson 1960
common redpoll	*Carduelis flammea*	Evans 1969; Kennard 1976; Pohl and West 1976, 1978
pine siskin	*Carduelis pinus*	Eriksson 1970, Harris 1975
American goldfinch	*Carduelis tristis*	Holcomb 1969, Miller 1978, Nickell 1951
lesser goldfinch	*Carduelis psaltria*	
green-tailed towhee	*Pipilo chlorura*	
rufous-sided towhee	*Pipilo erythrophthalmus*	Baumann 1959, Davis 1960, Greenlaw 1978
savannah sparrow	*Passerculus sandwichensis*	Bradley 1973, Dixon 1978, Welsh 1975, Wiens 1973
grasshopper sparrow	*Ammodramus savannarum*	Pulliam and Mills 1977, Smith 1963, Wiens 1973
vesper sparrow	*Pooecetes gramineus*	Best 1972, Pulliam and Mills 1977, Simpson 1978
lark sparrow	*Chondestes grammacus*	Renwald 1977
sage sparrow	*Amphispiza belli*	Braun et al. 1976, Moldenhauer 1970, Moldenhauer and Wiens 1970, Rich 1978a
northern junco	*Junco hyemalis*	Balph 1977, Gottfried and Franks 1975, Sabine 1959
American tree sparrow	*Spizella arborea*	Anderson 1973, Heydweiller 1935, Stenger 1965, Weeden 1958
chipping sparrow	*Spizella passerina*	Hebrard 1978, Klopfer 1965, Pulliam and Mills 1977
Brewer's sparrow	*Spizella breweri*	Best 1972, Braun et al. 1976, Rich 1978a
white-crowned sparrow	*Zonotrichia leucophrys*	Cortopassi and Mewaldt 1965, Lewis 1975, Morton et al. 1972, Rees 1973
golden-crowned sparrow	*Zonotrichia atricapilla*	Balph 1976

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
fox sparrow	*Passerella iliaca*	Banks 1970
Lincoln's sparrow	*Melospiza lincolnii*	Miller 1939, Miller and McCabe 1935
song sparrow	*Melospiza melodia*	Knapton and Krebs 1974, Nice 1943, Tompa 1962
Lapland longspur	*Calcarius lapponicus*	
snow bunting	*Plectrophenax nivalis*	Nethersole-Thompson 1966, Tinbergen 1939
	MAMMALS	
		Bailey 1936, Burt and Grossenheider 1964, Hall and Kelson 1959, Hansen 1956, Harvey 1976, McDaniel and Gardner 1977, McReynolds 1976, Mohr 1976, Shay 1973
Insectivora:		Terry 1978, Whitaker and Maser 1976
Soricidae—		
Malheur shrew	*Sorex preblei*	Armstrong 1957, Hoffman and Fisher 1978, Verts 1975
wandering shrew	*Sorex vagrans*	Clothier 1955, Hooven et al. 1975, Ingles 1961
Merriam shrew	*Sorex merriami*	Gashwiler 1976, Johnson and Clanton 1954, Lindsay and Perry 1977
Chiroptera:		Barbour and Davis 1969, Cross 1977, Saul et al. 1977
Vespertilionidae—		
little brown myotis	*Myotis lucifugus*	Buchler 1976, Fenton 1970, O'Farrell and Studier 1973
Yuma myotis	*Myotis yumanensis*	Dalquest 1947a
long-eared myotis	*Myotis evotis*	Dalquest 1948
fringed myotis	*Myotis thysanodes*	O'Farrell and Studier 1973, 1975
long-legged myotis	*Myotis volans*	Whitaker et al. 1977
California myotis	*Myotis californicus*	Krutzsch 1954, Whitaker et al. 1977
small-footed myotis	*Myotis leibi*	Fenton 1972, Tuttle and Heaney 1974
silver-haired bat	*Lasionycteris noctivagans*	Whitaker et al. 1977
western pipistrelle	*Pipistrellus hesperus*	Cross 1965, Hoff and Riedesel 1969
big brown bat	*Eptesicus fuscus*	Christian 1956, Davis et al. 1968, Kunz et al. 1977, Mills et al. 1975
hoary bat	*Lasiurus cinereus*	Constantine 1966, Findley and Jones 1964, Jones 1965, Sealy 1978a

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
spotted bat	*Euderma maculata*	Easterla 1971, Snow 1974b, U.S. Department of the Interior Bureau of Sport Fisheries and Wildlife 1973
western big-eared bat	*Plecotus townsendi*	Dalquest 1947b, Humphrey and Kunz 1976, Pearson et al. 1952
pallid bat	*Antrozous pallidus*	Beck and Rudd 1960, Davis 1969, Orr 1954
Lagomorpha:		
Leporidae—		
pygmy rabbit	*Sylvilagus idahoensis*	Orr 1940, Severaid 1950
mountain cottontail	*Sylvilagus nuttalli*	Chapman 1975, McKay and Verts 1978, Orr 1940
white-tailed jackrabbit	*Lepus townsendi*	Bear and Hansen 1966; James and Seabloom 1969a, 1969b
black-tailed jackrabbit	*Lepus californicus*	Blackburn 1968, Gross et all. 1974, Haskell and Reynolds 1947
Rodentia:		
Sciuridae—		
least chipmunk	*Eutamias minimus*	Meredith 1976, Sheppard 1965, Skryja 1974
yellow-pine chipmunk	*Eutamias amoenus*	Broadbooks 1958, 1970a, 1970b
yellow-bellied marmot	*Marmota flaviventris*	Armitage 1975, Armitage and Downhower 1974, Garrott and Jenni 1978
antelope ground squirrel	*Ammospermophilus leucurus*	Bradley 1967, 1968
Townsend ground squirrel	*Spermophilus townsendi*	Dalquest 1948, Johnson 1977, Shaw 1921
Richardson ground squirrel	*Spermophilus richardsoni*	Michener 1977, Michener and Michener 1977, Zegers 1976
Belding ground squirrel	*Spermophilus beldingi*	Morton and Gallup 1975, Morton and Sherman 1978, Turner 1972
mantled ground squirrel	*Spermophilus lateralis*	Gordon 1943, Tevis 1952, Yousef and Bradley 1971
Geomyidae—		
Townsend pocket gopher	*Thomomys townsendi*	Hall 1946, Horn 1923
northern pocket gopher	*Thomomys talpoides*	Anderson 1976, Hansen and Beck 1968, Julander et al. 1969
Heteromyidae—		
little pocket mouse	*Perognathus longimembris*	
Great Basin pocket mouse	*Perognathus parvus*	Hedlund et al. 1975, Kritzman 1974, O'Farrell et al. 1975, Scheffer 1938
dark kangaroo mouse	*Microdipodops megacephalus*	Ghiselin 1970, O'Farrell and Blaustein 1974

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
Ord kangaroo rat	*Dipodomys ordi*	Blaustein and Risser 1976, Lemen and Rosenzweig 1978, Whitford 1976
chisel-toothed kangaroo rat	*Dipodomys microps*	Beatley 1976, Jorgensen 1963, Kenagy 1973
Castoridae— beaver	*Castor canadensis*	Ffolliott 1976, Leege 1968, Rutherford 1964
Cricetidae— western harvest mouse	*Reithrodontomys megalotis*	Birkenholz 1967, Fisler 1971, Whitaker and Mumford 1972
canyon mouse	*Peromyscus crinitus*	Egoscue 1964, Lechleitner 1969
deer mouse	*Peromyscus maniculatus*	Blair 1943, King 1968, Kritzman 1974, Lawlor 1976, Wirtz and Pearson 1960
northern grasshopper mouse	*Onychomys leucogaster*	Egoscue 1960, McCarty 1978, Ruffer 1965
desert woodrat	*Neotoma lepida*	Bleich and Schwartz 1975, Stones and Hayward 1968
bushy-tailed woodrat	*Neotoma cinerea*	Findley 1958, Johnson and Hansen 1979
Microtidae— montane vole	*Microtus montanus*	Murie 1971, Murray 1965, Randall 1978
long-tailed vole	*Microtus longicaudus*	Beck and Anthony 1971, Randall 1978
sage vole	*Lagurus curtatus*	Clanton et al. 1971, Johnson et al. 1948, Maser et al. 1974, Maser and Strickler 1978
muskrat	*Ondatra zibethicus*	Kiviat 1978, Neal 1968b, Sather 1958, Willner et al. 1975
Zapodidae— western jumping mouse	*Zapus princeps*	Brown 1967, Cranford 1978, Jones et al. 1978
Erethizontidae— porcupine	*Erethizon dorsatum*	Hooven 1971, Smith 1977
Canidae— coyote	*Canis latrans*	Gier 1968, Knowlton 1972, Mathwig 1973
red fox	*Vulpes vulpes*	Sheldon 1949, Stanley 1963, Storm et al. 1976
kit fox	*Vulpes macrotis*	Egoscue 1975, Laughrin 1970, Snow 1973c
Procyonidae— raccoon	*Procyon lotor*	Fritzell 1978, Schneider et al. 1971, Urban 1970
Mustelidae—		Hamilton 1933, Heidt et al. 1976
long-tailed weasel	*Mustela frenata*	Hall 1951

Appendix 2 (continued)

Order, family, and common name	Scientific name	Reference
mink	*Mustela vison*	Errington 1943, Northcott et al. 1974, Shump et al. 1976a
badger	*Taxidea taxus*	Lindzey 1978, Sargeant and Warner 1972
spotted skunk	*Spilogale putorius*	Baker and Baker 1975, Crabb 1948, Patton 1974
striped skunk	*Mephitis mephitis*	Bailey 1971, Shump et al. 1975, Verts 1967
river otter	*Lutra canadensis*	Shump et al. 1976b, Tabor and Wight 1977, Toweill 1974
Felidae—		
cougar	*Felis concolor*	Hornocker 1970, Seidensticker et al. 1973, Sitton 1977
bobcat	*Lynx rufus*	Crowe 1975, Gashwiler et al. 1961, Sweeney 1977
Artiodactyla:		
Cervidae—		
mule deer	*Odocoileus hemionus*	Dealy 1970
Antilocapridae—		
pronghorn	*Antilocapra americana*	Autenrieth and Fichter 1975, Kitchen 1974, Sundstrom et al. 1973, Yoakum 1967
Bovidae—		
bighorn sheep	*Ovis canadensis*	Berger 1978, McGlinchy et al. 1971, Spalding and Mitchell 1970

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Man-made Habitats

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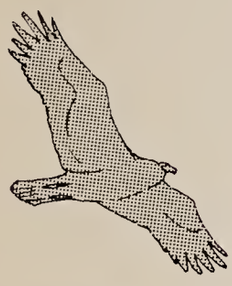
1979

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Manmade Habitats



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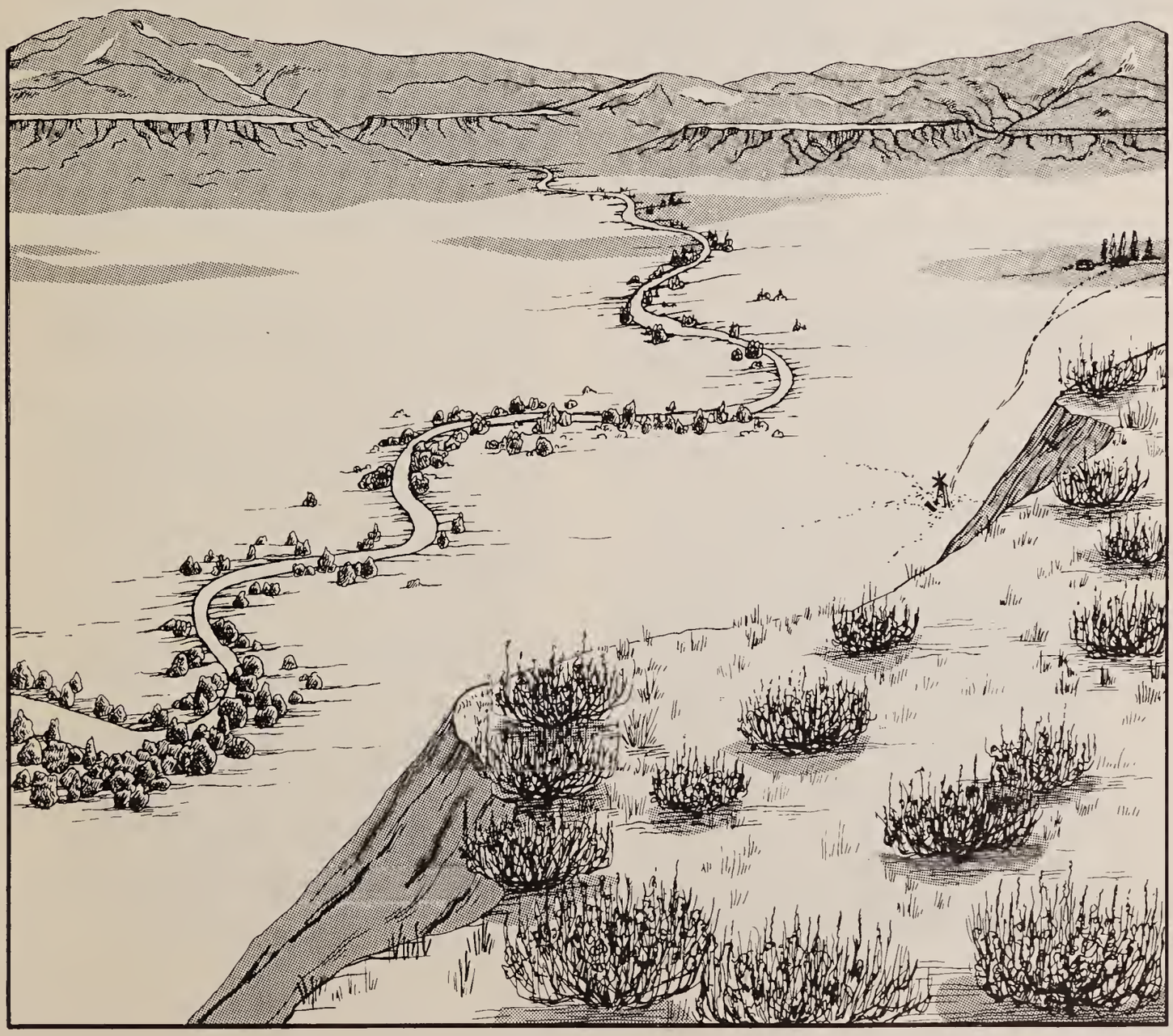

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ABSTRACT

Manmade structures on rangelands provide specialized habitats for some species. These habitats and how they function as specialized habitat features are examined in this publication. The relationships of the wildlife of the Great Basin to such structures are detailed.

KEYWORDS: Wildlife habitat, range management.

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This publication is part of the series **Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon**. The purpose of the series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands in order that the manager may make fully informed decisions.

The information in this series is specific to the Great Basin of Southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area but in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part will be an independent treatment of a specific subject, when combined in sequence, the individual parts will be as chapters in a book.

Individual parts will be printed as they become available. In this way the information will be more quickly available to potential users. This means, however, that the sequence of printing will not be in the same order as the final organization of the separates into a comprehensive whole.

A list of the publications in the series, their current availability, and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and United States Department of the Interior, Bureau of Land Management.

Introduction

Manmade structures, such as buildings, roads, bridges, rock walls, and wooden corrals and fences have long been a part of western rangelands. Although they were not built with an idea of blending into their surroundings, after being weathered and molded by the environment, these manmade intrusions become part of the landscape. Few men living can remember when they were not there. Such structures, when obviously "old" or of a past era, come to be considered as part of our national heritage and are preserved for the consideration and enjoyment of the public.

The rustic individualism reflected by these structures is captured by artists with brush and camera. But little does an artist know of the role the environment has played in molding their character. True, the builder has left behind the design of his labor, and weather and age have blended both labor and design into its surroundings. But, the sun and wind and rain and snow are not alone in contributing to making an abandoned homestead a thing of rustic attractiveness. The generations of plants and animals that live along each stretch of road and fence, under each bridge, and in and around each abandoned homestead add the final touches of individualism.

Although man has seldom viewed his intrusions into the environment as habitats for wildlife, their value as wildlife habitat is slowly being perceived. For example, Lustig (1976:4), in his article "Living Fences. . .An Alternative," put it this way:

> Robert Frost's poem 'Mending Fences' popularized the old proverb 'good fences make good neighbors.' However, for today's ecologically aware populus [sic], a more appropriate statement might be 'good fences bring good neighbors.' And so they do; both in urban and rural areas. . . . Any concerned land owner can easily change an ecologically sterile boundary line or fence row into a 'mini' wildlife sanctuary and thereby maximize the species diversity that he and his family can enjoy at their very doorsteps.

Structures, such as fences, have the potential to become habitats for wildlife. They provide certain habitat features that allow species to invade and to exist in areas that would be otherwise unsuitable. This effect is particularly pronounced in the Great Basin where the terrain is relatively gentle over vast expanses and the structural diversity of the vegetation is relatively simple.

In the wildlife sense, such structures may be thought of as manmade habitats (Appendix 1). A land manager should consider this aspect of old structures when decisions are made about their future.

It is the purpose of this discussion to point out wildlife habitat values of manmade structures in rangelands, and to make suggestions about how such habitat values may be enhanced.

Abandoned Homesteads

Abandoned homesteads have been and are being destroyed because of their ramshackle condition, hazard to humans or livestock, and other reasons. But, destruction of such historic sites on public lands appears to contradict the intent of the Historic Preservation Act (1966: 915) which states:

> . . .That Congress finds and declares—
>
> (a) That the spirit and direction of the Nation are founded upon and reflected in its historic past;
>
> (b) That the historical and cultural foundations of the Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the American people;
>
> (c) That, in the fact of ever-increasing extensions of urban centers, highways, and residental, commercial, and industrial developments, the present governmental and nongovernmental historic preservation programs and activities are inadequate to insure

future generations a genuine opportunity to appreciate and enjoy the rich heritage of our Nation. . . .

Further, the National Environmental Policy Act (1969, p. 852), under "Title 1, Declaration of National Environmental Policy," states that:

> (4) preserve important historic, cultural, and natural aspects of our heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice. . . .

And destruction of homesteads is not in keeping with Bureau of Land Management policy (United States Department of the Interior Bureau of Land Management Manual 6231).

The most obvious management interest in abandoned homesteads is for their historical and cultural value. But they also provide wildlife habitat. Most abandoned homesteads have four features that make them valuable as habitat—buildings and associated structures, introduced vegetation, a permanent source of water, and a creation of diversity in an otherwise homogeneous habitat. Any or all of the following features may be found around these old homesteads: house and outbuildings, rock or rail fences, irrigation ditches, root cellars, primitive roads, culverts, ponds, springs, wells, ornamental trees and shrubs, fruit trees, refuse piles or pits, abandoned machinery, and fenced grave sites.

BUILDINGS

Abandoned wooden buildings (fig. 1) serve as habitat for a variety of animals (Bailey 1936, Orr 1954, Stebbins 1954, 1966). Lizards and snakes use them for sunning, shade, and shelter, as places to feed, and as reproductive sites. Screech owls (*Otus asio*) use building-interiors for roosting and rearing young. Barn swallows (*Hirundo rustica*) nest inside buildings (fig. 2), and cliff swallows (*Petrochelidon pyrrhonota*) construct nests on the outer walls. Common flickers (*Colaptes auratus*) often peck holes through the outer wall of "double-walled" buildings and nest in the interspaces (fig. 3). These "cavities" are secondarily inhabited by bats (Orr 1954), chipmunks (*Eutamias* spp.), deer mice (*Peromyscus maniculatus*), woodrats (*Neotoma* spp.), American kestrels (*Falco sparverius*), and starlings (*Sturnus vulgaris*).

Bats use the interior of old buildings as night roosts where they hangup while digesting their food; bats may also use them as sites in which to hibernate (Barbour and Davis 1969, Orr 1954). Buildings which are located in cool sites and have tarpaper siding may have bats roosting under the tarpaper during the day.

Figure 1.—Abandoned wooden buildings (homesteads) serve as habitat for a variety of wildlife species. The introduced vegetation is particularly important to birds. (Bureau of Land Management photograph)

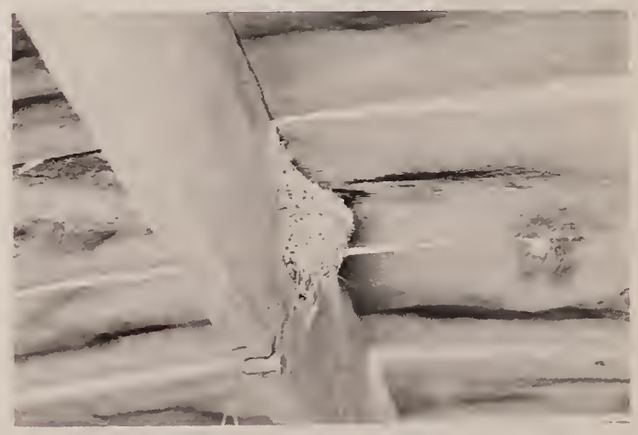

Figure 2.—A barn swallow (*Hirundo rustica*) nest on a beam inside an abandoned wooden building. (Chris Maser photograph)

Figure 3.—Common flickers (*Colaptes auratus*) often peck holes through the outer wall of "double-walled" buildings and nest in the interspaces. In this case, the holes are in the wall under the overhang of the roof. These "cavities" are secondarily inhabited by other species of wildlife. (Chris Maser photograph)

Figure 4.—A deer mouse (*Peromyscus maniculatus*) nest within the top of the door casing of an abandoned homestead. (Chris Maser photograph)

Larger animals, such as mountain cottontail rabbits (*Sylvilagus nuttalli*), ground squirrels (*Spermophilus* spp.), yellow-bellied marmots (*Marmota flaviventris*), long-tailed weasels (*Mustela frenata*), striped skunks (*Mephitis mephitis*), spotted skunks (*Spilogale putorius*), and badgers (*Taxidea taxus*), live under buildings, whereas deer mice (fig. 4) and woodrats (fig. 5) frequent all stories. Even collapsed wooden buildings and piles of wooden fence posts are used as shelter and as sites for rearing young by lizards, snakes, mountain cottontail rabbits, yellow-bellied marmots, ground squirrels, woodrats, deer mice, long-tailed weasels, and others.

Abandoned wooden buildings are used as hiding and thermal cover, and as sites for reproduction, feeding, hibernation, sunning, and as elevated lookouts by a variety of wildlife. Buildings constructed of rock (fig. 6) are more important than are wooden buildings as habitat for lizards, snakes, and digging rodents, such as ground squirrels and marmots, because they more closely simulate their natural habitat.

Figure 5.—Bushy-tailed woodrat (*Neotoma Cinerea*) nest in the attic of an abandoned homestead. (Chris Maser photograph)

Figure 6.—Buildings constructed of rock are important as habitat for lizards, snakes, and digging rodents because they more closely simulate their natural habitat. (Bureau of Land Management photograph)

The concentration of animals is, in turn, attractive to predators. Predators frequently found in association with abandoned buildings include hawks, owls, long-tailed weasels, badgers, coyotes (*Canis latrans*), and bobcats (*Lynx rufus*).

INTRODUCED VEGETATION

Homesteaders often planted shade and fruit trees and shrubs. Many abandoned home sites still have Lombardy poplars (*Populus nigra*) (fig. 7), white poplars (*Populus alba*) (fig. 8), cottonwoods (*Populus* spp.), and black locusts (*Robinia pseudoacacia*) growing around them. These trees stand out in stark contrast to a generally treeless landscape and are commonly used as perching sites and nesting locations for such birds as northern orioles (*Icterus galbula*), western kingbirds (*Tyrannus verticalis*), black-billed magpies (*Pica pica*) (fig. 9), black-headed grosbeaks (*Pheucticus melanocephalus*), red-tailed hawks (*Buteo jamaicensis*) (fig. 10), ferruginous hawks (*Buteo regalis*), golden eagles (*Aquila chrysaetos*), great

Figure 7.—The tall, narrow trees are Lombardy poplars (*Populus nigra*). They are not self-producing. (Bureau of Land Management photograph)

Figure 8.—White poplars (*Populus alba*) are self-producing. Note the young trees in the lower right corner. (Chris Maser photograph)

Figure 9.—Black-billed magpies (*Pica pica*) often perch and nest in trees around abandoned homesteads. (Robert R. Kindschy photograph)

Figure 10.—Red-tailed hawks (*Buteo jamaicensis*) are one of the raptors that nest around abandoned homesteads. (Robert R. Kindschy photograph)

horned owls (*Bubo virginianus*), long-eared owls (*Asio otus*), and flickers (Marion and Ryder 1975, Olendorff and Stoddart 1974, Schnell 1968, Seibert et al. 1976, Smith et al. 1972, Snow 1974a, Woffinden 1975). Common flickers excavate cavities in dead trees and in dead limbs on live trees. The abandoned nest-cavities are secondarily used by mountain bluebirds (*Sialia currucoides*), western bluebirds (*Sialia mexicana*), starlings, violet-green swallows (*Tachycineta thalassina*), American kestrels, and bats. In addition, hoary bats (*Lasiurus cinereus*) roost in the foliage of these trees during their spring and fall migrations (Bailey 1936, Constantine 1959, 1966). Many homesteads also have shrubs around them—some introduced, some native. Shrubs are used for nesting by such birds as gray flycatchers (*Empidonax wrightii*), house finches (*Carpodacus mexicanus*), and lazuli buntings (*Passerina amoena*). The presence of trees and shrubs greatly increases habitat diversity. Trees are particularly important in this regard (fig. 11).

Figure 11.—The trees that were planted around old homesteads are particularly important as habitat for nesting birds. (Bureau of Land Management photograph by M. Hurd)

WATER

Homesteads were normally located near a source of permanent water, usually a spring, stream, or river. Springs that were made into reservoirs, but not maintained, often developed riparian and aquatic vegetation (fig. 12). Some reservoirs contain fish and bullfrogs (*Rana catesbeiana*). Western harvest mice

Figure 12.—Springs that were made into reservoirs, but then were no longer maintained, often developed riparian and aquatic vegetation. (Bureau of Land Management photograph by Robert R. Kindschy)

(*Reithrodontomys megalotis*) and montane voles (*Microtus montanus*) may occupy the marshy areas; and yellow warblers (*Dendroica petechia*), short-eared owls (*Asio flammeus*), American avocets (*Recurvirostra americana*), red-winged blackbirds (*Agelaius phoeniceus*), killdeer (*Charadrius vociferus*), mallards (*Anus platyrhynchos*) (fig. 13), cinnamon teal (*Anus cyanoptera*), marsh hawks (*Circus cyaneus*) (fig. 14), and other birds nest in and around the riparian vegetation (Evans and Kerbs 1977, Greenwell 1952). In addition, migratory waterfowl are frequent visitors during the spring and fall.

Figure 13.—Mallards (*Anus platyrhynchos*) can be found nesting in marshy areas surrounding homestead reservoirs that are no longer maintained.

Figure 14.—Marsh hawks (*Circus cyaneus*) also nest in marshy areas surrounding homestead reservoirs that are no longer maintained.

The presence of the water attracts many animals. Tracks of California quail (*Lophortyx californicus*), rabbits, mule deer (*Odocoileus hemionus*), pronghorns (*Antilocapra americana*), coyotes, and bobcats are often observed near water.

DIVERSITY

Buildings, trees, shrubs, and permanent sources of water associated with abandoned homesteads provide three essential habitat components—food, water, and cover—in a relatively small area. This combination contrasts dramatically with the surrounding, comparatively sterile, habitats (fig. 15). In so doing, they add greatly to the diversity and richness of an area. Abandoned homesites, then, provide habitat for species that would be otherwise scarce or absent in the locale. They also act to concentrate a number of common species.

Figure 15.—Old homesteads contrast dramatically with the surrounding, relatively homogeneous rangeland habitats. (Bureau of Land Management photograph by Robert R. Kindschy)

Some habitat attributes created by abandoned homesteads are relatively unstable, and time exacts a toll on many of them. Wooden buildings are dismantled, vandalized, burned, or gradually deteriorate. Some of the introduced vegetation, such as Lombardy poplar, is not self-reproducing and gradually dies.

Diversity created by abandoned homesteads is long lasting but changes over time. For example, vegetation, such as white poplar, is self-perpetuating and can remain more or less intact for over a century. The source of water, however, preceded the homestead and will outlast it (fig. 16). These abandoned works of man, therefore, enhance the habitat for a variety of species of wildlife for a time, allowing some to live in areas that otherwise would be unsuitable.

Roads and Bridges

Unpaved roads are highly visible features of managed rangelands; there are thousands of miles of such roads in the Great Basin. The terrain crossed by some roads necessitates the building of bridges. Although roads and bridges improve or create habitat for some species of wildlife, they degrade or destroy habitat for others. This statement may also apply to paved roads (Leedy 1975, Leedy et al. 1975).

ROADS

Although there are some positive effects of roads on some wildlife species, in general, roads have adverse effects on the broad spectrum of wildlife regardless of where or how they are constructed (Oxley et al. 1974). Adverse effects are compounded when roads are built in or adjacent to riparian zones.

The positive habitat values of rangeland roads lie primarily in their design and con-

Figure 16.—Habitat diversity created by abandoned homesteads is long lasting and changes over time. Ultimately, the source of water that preceded the homestead will outlast it.

Figure 17.—Roadbanks and roadsides often enable a type of vegetation to become established that differs from that of the surrounding country, creating habitat diversity and edge-effect.

struction. Roadbanks cut into uneven terrain may require stabilization to prevent erosion, but roadsides through even terrain seldom need to be stabilized. Roadbanks and roadsides often enable a type of vegetation to become established that differs from that of the surrounding country, creating habitat diversity and edge-effect (fig. 17).

Habitat changes may be produced by exposure of several soil horizons of different textures, removal of top soil, piles of loose soil and rock, creation of moister conditions in borrow ditches and pits, installation of culverts, fertilization of cuts and fills, seeding raw banks, etc. Such alterations are particularly important as habitat where conditions are created that did not previously exist and there are wildlife species that can exploit them.

These areas are often "colonized" by ground squirrels (*Spermophilus* spp.), pocket mice (*Perognathus* spp.), kangaroo rats (*Dipodomys* spp.), voles (*Microtus* spp.), rabbits, and hares (*Lepus* spp.) (Douglas and Johnson 1972), and may act as routes of dispersal from one area to another by forming a physical link of suitable habitat through otherwise uninhabitable terrain. For example, Getz et al. (1978) wrote:

> Roadsides that provide habitats different from those occurring in adjacent areas are potential avenues of dispersal for various groups of animals. In particular, this applies to those roadsides that have dense grassy vegetation. Such roadsides provide dispersal routes for grassland species. . . .

A somewhat different set of circumstances applies to minimum standard roads through flat terrain in areas of the Great Basin. In this case, a roadbed is often lower than the "bank" because the debris (soil and rocks) is simply pushed aside with a bulldozer, creating small cuts and ridges along the road's edge (figs. 18 and 19). Soil in these ridges is often better drained and remains more friable than does that of the surrounding flatlands, particularly when much clay is present. The combination of better drainage and greater friability allows animals, such as kangaroo rats, which are relatively poor diggers, to live in and disperse along the soil ridges. This is especially important when the surrounding flatland soil is saturated with water during the winter or when it is too hard for them to dig through during the summer. Soil ridges often are nearly free of perennial vegetation and are gradually built up through additional soil deposits during road maintenance activities, thus providing a well-defined habitat.

At times, construction results in piles of debris (soil, rocks, and brush) along a road. These piles become inhabited by animals such as ground squirrels, kangaroo rats, pocket mice, harvest mice, deer mice, and sage voles (*Lagurus curtatus*). Although the piles offer elevated sites with better drainage and easier digging, they are usually scattered in distribution and may take longer to be occupied. Most of the debris piles seem to be unaffected by

Figure 18.—Construction of minimum standard roads through flat terrain may create small roadbanks, thereby adding to habitat diversity. (Bureau of Land Management photograph)

Figure 19.—Construction of minimum standard roads through flat terrain may create small ridges of soil. Soil in these ridges is often better drained and remains more friable than does that of the surrounding flatlands, making it good habitat for small mammals, such as the Ord kangaroo rat (*Dipodomys ordi*). (Chris Maser photograph)

Figure 20.—Road construction with a bulldozer through rocky soil—especially soil containing large rocks and boulders—creates a ridge strewn with large individual rocks or clusters of big rocks. Mantled ground squirrels (*Spermophilus lateralis*) and yellow-bellied marmots (*Marmota flaviventris*) are closely associated with large rocks which serve as elevated lookouts, and large roadside rocks have allowed both rodents to survive in and disperse through otherwise unsuitable habitats. (Chris Maser photograph)

road maintenance and gradually blend into the surrounding landscape. As they become overgrown with vegetation, they gradually lose their habitat-qualities for kangaroo rats, but become better habitat for mice and voles.

Due to their scattered distribution, debris piles appear to be less important as dispersal routes than do the soil ridges.

Talus formations are mimicked by large rock and boulder ridges and land-fills created during road construction. This type of roadside talus, which may be inhabited by marmots, ground squirrels, woodrats, mice, weasels, and other animals, is normally restricted in distribution. On the other hand, road construction with a bulldozer through rocky soil—especially soil containing large rocks and boulders—creates a ridge strewn with large individual rocks or clusters of big rocks (fig. 20). These talus-like rows of large rocks are used by lizards, marmots, and mantled ground squir-

rels (*Spermophilus lateralis*). Mantled ground squirrels and yellow-bellied marmots are closely associated with large rocks which serve as elevated lookouts, and large roadside rocks have allowed both rodents to survive in and disperse through otherwise unsuitable habitats.

The occupancy of these roadside habitats by reptiles and small mammals provides prey for predators and food for scavengers. The combination of animals and vehicular traffic produces a situation where many animals are killed by cars or by shooting from cars (Case 1978, Oxley et al. 1974). Consequently, there seems to be a concentration of predators and scavengers along such roads, including snakes, hawks, owls, turkey vultures (*Cathartes aura*), common crows (*Corvus brachyrhynchos*), common ravens (*Corvus corax*), black-billed magpies, coyotes, and long-tailed weasels.

Where road construction and maintenance creates ditches, water often collects and remains available to wildlife for varying periods following rain storms. This frequently creates areas where the vegetation receives greater than normal moisture and in turn produces more biomass that remains green longer. In rare circumstances, the collection of water within borrow pits and ditches forms areas where aquatic or riparian zone vegetation may be found. These more mesic conditions in a typically xeric landscape contribute to diversity and are often attractive to wildlife for water, food, and cover.

For the broad spectrum of wildlife, on the other hand, roads largely destroy habitat and often promote soil erosion (Kitchings et al. 1974), but their greatest long-term impact on wildlife is increased human access and increased use of previously remote areas (Albrecht and Smith 1977, Davey 1974, Snyder et al. 1976). Greater vehicular access, unless carefully managed, intensifies fishing, hunting, and trapping pressures on animals, such as Alvord cutthroat trout (*Salmo clarki* subspecies), jackrabbits (fig. 21), ground squirrels, coyotes, badgers, bobcats (fig. 22), pronghorns, and mule deer.

Increased access also allows these pressures to be more evenly distributed. There is

Figure 21.—Black-tailed jackrabbits (*Lepus californicus*) are often hunted for sport; increased vehicular access into an area will intensify the hunting pressures on this species and on others. (Robert R. Kindschy photograph)

Figure 22.—Greater vehicular access, unless carefully managed, intensifies trapping pressures on fur-bearing mammals, such as the bobcat (*Lynx rufus*). (Robert R. Kindschy photograph)

little doubt that access augments the potential for enjoyment and exploitation of the wildlife resource, but this can be good or bad depending on the wildlife management objective and the intensity of the management, including enforcement of regulations. Improved access, however, is seldom related to a wildlife management objective. The impacts on wildlife, therefore, are apt to be negative.

Greater access also intensifies harassment of species, such as the sage grouse (*Centrocercus urophasianus*), ferruginous hawk (Olendorff and Stoddart 1974, Snow 1974a), prairie falcon (*Falco mexicanus*) (Parker 1973, Snow

1974b), Peregrine falcon (*Falco peregrinus*)—listed as endangered—(Federal Register 1976, Porter et al. 1973, Snow 1972), and the golden eagle (Snow 1973). For example, Ellis et al. (1969) documented a loss of 30 raptors along a 19-kilometer (12 mi) segment of a powerline. Fourteen of the birds were golden eagles, and most of the carcasses had bullet wounds. Mortality by shooting appears to occur most frequently when powerlines and roads are within 183 meters (600 ft) of each other.

BRIDGES

Although bridge construction alters the habitat at the site, bridges may produce new wildlife habitat-values, depending on the type of bridge. Bridges of creosote-impregnated wood exhibit little or no value as wildlife habitat (fig. 23). Unimpregnated, wooden bridges appear to have limited value to nesting swallows and roosting bats, but these bridges tend to vibrate. Traffic on such bridges is quite noisy and creates dust. When wooden bridges are abandoned, however, they become more valuable as wildlife habitat. The creosote is leached away over time and the absence of traffic reduces the disturbance to wildlife.

On the other hand, traffic over concrete bridges (fig. 23) is relatively quiet when compared to that crossing wooden bridges. Concrete bridges do not allow dust to sift through, and in addition produce shade, a cool microclimate, and simulate cliffs and caves. The concrete surface provides a structure which allows barn swallows and cliff swallows to build their nests on the suspension beams. Some species of bats, such as little brown myotis (*Myotis lucifugus*), Yuma myotis (*Myotis yumanensis*), California myotis (*Myotis californicus*), big brown bats (*Eptesicus fuscus*), and pallid bats (*Antrozous pallidus*), use the concrete surfaces under bridges as night-roosts (Greenhall and Paradiso 1968, Maser[1], Orr 1954). When available, suitable cracks and crevices in the concrete are used as day-roosts and sites for rearing young by such species as the pallid bat (Krutzsch 1946, Orr 1954, Storer 1931).

In addition, bridges—especially concrete bridges—produce a cool microclimate that is attractive to flying insects. Such insects, in turn, provide a food source for the insectivorous birds and bats that are associated with the bridges.

[1]Maser, Chris. Unpublished data on file at the Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington.

Figure 23.—Bridges of creosote-impregnated wood exhibit little or no value as wildlife habitat. They are noisy and dusty. Concrete bridges, on the other hand, are relatively quiet and do not allow dust to sift through. In addition, they produce shade, a cool microclimate, and simulate cliffs and caves. If a bridge (wooden or concrete) with well-established wildlife use is to be replaced, it may be desirable to construct the new bridge alongside of the old one, retaining the old bridge as wildlife habitat.

Rock Walls, Rock Jacks, Rock Cribs, and Sheepherder Monuments

Due to their mode of construction—essentially loose piles of large, irregular rocks—rock walls, rock jacks, rock cribs, and sheepherder monuments all simulate talus. These rock piles are honey-combed with protected spaces which provide shelter from the elements for a variety of species. The spaces are sheltered from winter winds thereby reducing the chill factor, but on the other hand, these spaces are much cooler than surrounding areas in summer.

Such spaces are used by a variety of prey species—vertebrate and invertebrate—which in turn are consumed by predators. The animal biomass associated with these structures seems to be much greater than in similar areas lacking them (Sinclair et al. 1967).

ROCK WALLS

Walls constructed of rock, usually lava, provide stable habitats for a variety of animals (Lustig 1976, Sinclair et al. 1967) (fig. 24). Lizards, such as western fence lizards (*Sceloporus occidentalis*) and side-blotched lizards (*Uta stansburiana*); snakes, such as blue racers (*Coluber constrictor*), gopher snakes (*Pituophis melanoleucus*), and western rattlesnakes (*Crotalus viridis*) (fig. 25); birds, such as rock wrens (*Salpinctes obsoletus*), canyon wrens (*Catherpes mexicanus*), and Say's phoebes (*Sayornis saya*); and mammals, such as mountain cottontail rabbits, chipmunks, yellow-bellied marmots, ground squirrels, deer mice, canyon mice (*Peromyscus crinitus*), woodrats, long-tailed weasels, and skunks, all use rock walls for feeding and for reproduction (Bailey 1936, Burt and Grossenheider 1964, Maser [unpublished data][2], Peterson 1961, Stebbins 1954, 1966). Some animals, such as lizards, snakes, and ground squirrels, spend much time sunning themselves on the walls during the spring, summer, and fall, and hibernate in or beneath the walls during the winter. These, and other animals, also depend upon the walls as elevated lookouts.

Figure 24.—Rock walls, usually made of lava, provide stable habitats for a variety of animals. (Bureau of Land Management photograph)

Figure 25.—The western rattlesnake (*Crotalus viridis*) is a frequent inhabitant of rock walls. (Bureau of Land Management photograph by Grant Baugh)

ROCK JACKS

Rock jacks (fig. 26) are usually built so that the rocks are initially elevated off of the ground. When the supporting wooden structure deteriorates, the pile of rocks has a habitat function similar to that of the rock cribs discussed next. The distance above ground determines which animals can seek shelter

[2]See footnote 1.

Figure 26.—A rock jack is usually built so that the rocks are initially elevated off of the ground. (Chris Maser photograph)

Figure 27.—Since rock jacks are used to stabilize fences, they are incorporated into kilometers (miles) of livestock fence. As a result, they form dispersal routes through otherwise uninhabitable terrain. In this case a desert woodrat (*Neotoma lepida*) is inhabiting such a rock jack, as evidenced by its nest. (Chris Maser photograph)

beneath them. For example, a rock jack in which the bottom rocks are 15 cm (6 in) above the ground creates a large enough space for a mountain cottontail, whereas a Townsend ground squirrel (*Spermophilus townsendi*) can utilize a space that is only 10 cm (4 in) high, and a rattlesnake can use a 5-cm (2-in) space.

Rock jacks constructed with large rocks, 30 to 60 cm (12 to 34 in) in diameter, show greater use by wildlife (reptiles, birds, and mammals) than do those composed of rocks less than 30 cm (12 in).

Wildlife uses of rock jacks are varied; they include: feeding, reproduction, escape, shade, shelter from wind, sunning, perching, and lookouts. Since rock jacks are used to stabilize fences, they are incorporated at varying intervals, usually 30 to 50 meters (98 to 164 ft) into kilometers (miles) of livestock fence. As a result, they form dispersal routes through otherwise uninhabitable country for animals, such as the desert woodrat (*Neotoma lepida*) (fig. 27).

ROCK CRIBS

Rock cribs (figs. 28 and 29) offer essentially the same function as wildlife habitat as do rock jacks, but for a smaller variety of species. Since rock cribs rest on the ground surface, wildlife use is limited to those species that can climb within or on top of the rocks. Cottontail rabbits, for example, are largely eliminated as users of rock cribs, but lizards, snakes, woodrats, ground squirrels, and weasels have free access to the security of a crib. As with rock jacks, the size of the rocks used in construction also determines which species can use a rock crib. Albeit, small rocks, 15 to 20 cm (6 to 8 in) in diameter, give an appearance of "neatness"

Figure 28.—A wooden rock crib, if constructed with large rocks, has essentially the same function as wildlife habitat as does a rock jack. Since the rocks are not initially elevated off of the ground, however, a few of the larger animals, such as the mountain cottontail rabbit (*Sylvilagus nuttalli*), may be excluded from inhabiting wooden rock cribs. (Chris Maser photograph)

Figure 29.—A wire rock crib can be used as habitat by animals as large as Belding ground squirrels (*Spermophilus beldingi*). Larger animals are excluded, however, by the smaller-sized rocks used in these cribs and by the diameter of the wire mesh. (Chris Maser photograph)

Figure 31.—Sheep-herder monuments consist of piles of rocks. (Bureau of Land Management photograph)

Figure 32.—Sheep-herder monuments are often located on or near the tops of hills and serve as perching sites for raptors, such as golden eagles (*Aquila chrysaetos*). (Bureau of Land Management photograph)

and are sometimes thought to be more esthetically pleasing, the "neatness" and "esthetics" of a crib made with small rocks diminishes its usefulness to wildlife (fig. 30).

Rock cribs are also used to stabilize fences and may create routes of dispersal for some species of wildlife.

Figure 30.—A "neat" or "esthetically pleasing" wire rock crib is made with small rocks which lack the large spaces between them, and a small-mesh wire is used to contain the rocks. This combination of construction materials can eliminate all but the smaller animals, such as deer mice (*Peromyscus maniculatus*) or desert woodrats (*Neotoma lepida*), from using such a rock crib as habitat. (Bureau of Land Management photograph by A. K. Majors)

SHEEPHERDER MONUMENTS

Sheepherder monuments (figs. 31 and 32), which are more or less randomly distributed, consist of piles of rocks. They serve essentially

the same habitat function for wildlife as do rock jacks and rock cribs, but do not form dispersal routes. Often located on hill tops, they serve as perching sites for raptors, such as golden eagles.

Wooden Corrals and Fences

Wooden corrals (figs. 33 and 34), and fences with wooden posts (fig. 35) appear to belong largely to past decades. Most new fences are constructed with steel posts.

Although often associated with old homesteads, wooden fences also may be isolated from such sites. Those few that remain are used by western fence lizards for sunning and by chipmunks, raptors, shrikes (*Lanius* spp.), and other birds as lookouts. In addition, shade from these posts is sought by lizards, snakes, small birds, and small mammals to escape the heat on hot cloudless days.

Figure 33.—Wooden corrals are used as perches by many birds. (Chris Maser photograph)

Figure 34.—In addition to providing perches for birds, wood corrals can also provide animals with shade and protection from wind. (Chris Maser photograph)

Figure 35.—The wooden posts in this fence can be used as perches by birds and as shade by small, ground-dwelling animals on hot, cloudless days. (Bureau of Land Management photograph)

Cavities are often found in decaying fence posts and are used by small cavity-nesting birds such as bluebirds, house wrens (*Troglodytes aedon*), swallows, chickadees (*Parus* spp.), and mammals such as bats, deer mice, and chipmunks. These sources of nesting sites allowed some species to temporarily invade otherwise unsuitable habitats, and a species'

Figure 36.—Fences frequently occur along edges between vegetation of different types or different structural conditions. Fences, in this sense, created and/or maintain habitat diversity and often are particularly rich in wildlife. (Bureau of Land Management photograph)

decline in such areas may be related to the gradual loss of that habitat.

Fences frequently occur along edges between vegetation of various types or in different stages of development (fig. 36). As such, they are of particular value to some species and are often particularly rich in wildlife.

Powerlines

Powerlines have become common and, perhaps, inevitable features of the landscape. They have potential as wildlife habitat and have other influences on wildlife. The impacts of powerlines on wildlife depend on: (1) size of lines, poles, and towers, (2) voltage of lines, (3) location, size, and shape of rights-of-way, and (4) the type of vegetation management within rights-of-way.

POWERLINES, POLES, AND TOWERS

Raptors, such as golden eagles, red-tailed hawks, and ferruginous hawks, use powerlines, poles, and towers as sites for perching and nesting (Gilmer and Wiehe 1977, Marion and Ryder 1975, Olendorff 1972, Olendorff and Stoddart 1974). In early years, small distribution lines, such as the Rural Electrification Administration (REA) type, electrocuted many raptors, especially golden eagles (Boeker 1974, Boeker and Nickerson 1975, Fitzner 1975, Harrison 1963, Olendorff 1972, Smith and Murphy 1972, Snow 1973). In recent years, however, powerlines, poles, and towers have been modified not only to make lines safe for raptors but also to adapt poles and towers as sites for perching and for nesting (Miller et al. 1975, Nelson and Nelson 1977). Thus, in some cases, it has been possible to turn a wildlife liability into an asset.

In addition, many birds are killed when they collide with towers and lines, particularly small-diameter, closely spaced transmission and secondary distribution lines (Anderson 1978, Anderson et al. 1975, Kemper 1964, Krapu 1974, Scott et al. 1972, Stout and Cornwell 1976). Satisfactory solutions to this problem have yet to be found.

Extra high voltage power lines (500 KV+) produce a corona effect—ozone production, noise, and flashes of light. Although the unusual olfactory, auditory, and visual stimuli of the corona effect may be adverse to wildlife (Kline 1971, Young 1973), such adversity has not been conclusively proven (Goodwin 1975).

Extra high voltage power lines (500 KV+) also produce electric and magnetic field effects. These fields can induce voltages and currents in plants and animals near such lines (Jack Lee, personal communication, Miller and Kaufman 1978). But thus far, no adversity to wildlife has been demonstrated by the electric field effect (Bankoske et al. 1976).

RIGHTS-OF-WAY

Managed rights-of-way are beneficial to some wildlife and detrimental to others. The two primary features of rights-of-way that influence wildlife are alteration of existing vegetation and increased human access via roads.

In many areas, the most obvious feature of a right-of-way is alteration of the habitat within it. Tall vegetation, such as trees and shrubs, are initially eliminated. Subsequent management may maintain the vegetation in the right-of-way in an earlier, lower structural condition (fig. 37). If efforts are not made to remove trees and shrubs as they reappear, the site may return to its original condition. Thus, plant species composition and diversity may not be significantly affected over time (Ludwig et al. 1977, Potter and Krenetsky 1967).

Where heavy shrub growth is removed or trees are felled to clear a right-of-way, there should be a corresponding increase in grasses and forbs (Barney and Frishknecht 1974, Clary 1974, Erdman 1970, Ludwig et al. 1977). Although increases may be related to an increased amount of sunlight and consequent drying of the site (Jameson 1970), there is considerable annual variability in herbage production which is presumably a product of precipitation. If undisturbed, a site will progress by stages back to its original structural condition (Barney and Frishknecht 1974).

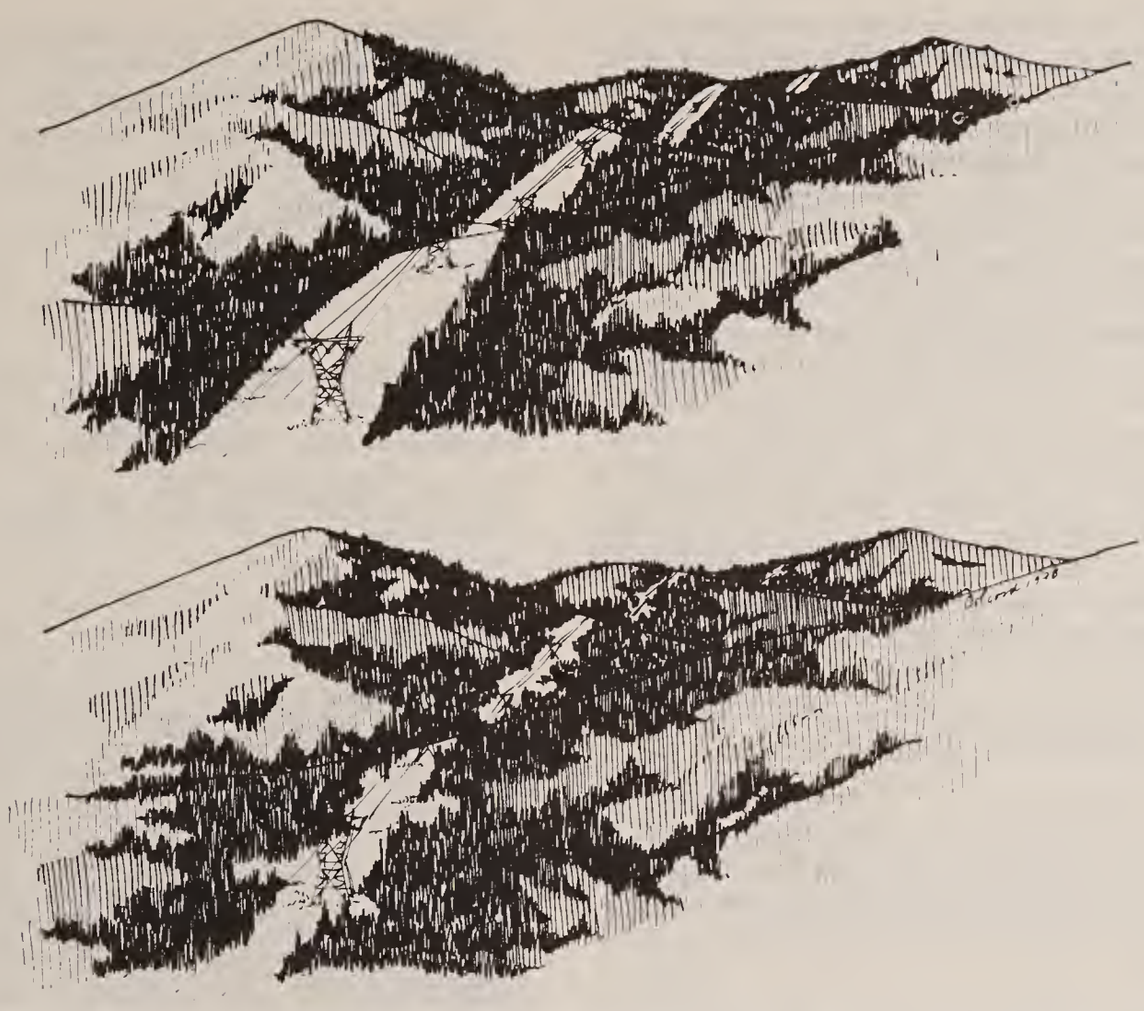

Figure 37.—In many areas, the most obvious feature of a right-of-way is alteration of the habitat within it. Once established, subsequent management may maintain the vegetation in a right-of-way in an earlier, lower structural condition. Powerline rights-of-way can be designed with irregular borders to enhance edge effect and to make them as aesthetically pleasing as possible.

Right-of-way construction can either create or deplete habitat diversity. For example, a right-of-way through a small, isolated stand of juniper will eliminate a locally rare habitat, reduce contrast, eliminate edge, and thereby reduce habitat diversity. Whereas a right-of-way through an extensive stand of juniper will open up some of the stand, create a new structural condition, produce edge, and thereby increase habitat diversity.

Where diversity has been created by a right-of-way, Anderson et al. (1977) found that bird species diversity was correlated with the width of the right-of-way. This was due to habitat alteration of sufficient size to support those species of birds that required either the type of habitat created, or the edge-effect, or both. There is some evidence to indicate that mammals react to rights-of-way in a similar fashion (Goodwin 1975, Schreiber and Graves 1977).

It is doubtful that maintenance of powerline rights-of-way in rangelands will require extensive manipulation of vegetation since most plant communities are relatively low in structure. Where such manipulation is required, however, application of herbicides is the treatment often used.

Application of herbicides to control sagebrush (*Artemisia* spp.) in rights-of-way adversely affects some species, such as the sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), and sage grouse

(Baker et al. 1976, Braun and Beck 1976, Gabrielson and Jewett 1970, Klebenow 1969, Schroeder and Sturges 1975). Treatment may not only reduce local populations of sage grouse (Klebenow 1970, Rogers 1964) but also may detrimentally affect food supplies of pronghorns and mule deer on the immediate winter range (Cole 1956, Martinka 1967, Smith 1959). Further, spraying rights-of-way for shrub control may locally reduce or eliminate forbs and arthropods that are important sources of food for some species of wildlife, such as leopard lizards (*Crotaphytus wislizeni*), blue racers, sage grouse, loggerhead shrikes (*Lanius ludovicianus*), northern grasshopper mice (*Onychomys leucogaster*), and sage voles (Martin 1970, Maser et al. 1974, Parker and Pianka 1976, Peterson 1970, Tanner and Krogh 1974). This, in turn, affects the food supply of predators, such as gopher snakes and burrowing owls (*Athene cunicularia*) (Marti 1974, Maser et al. 1971, Zarn 1974).

Maintenance of rights-of-way for powerlines, however, usually involves only a minor portion of the general area. While impacts on wildlife may be pronounced on the areas treated, the overall effect may be quite small.

The reduction of the vegetation from shrubs, trees, or both to a grass-forb condition will benefit species that are adapted to such conditions, for example, the horned lark (*Eremophila alpestris*). Rights-of-way will also provide pronounced edges between woody vegetation and largely herbaceous vegetation. Edges, in turn, are indicative of some measure of diversity in a rather homogeneous habitat.

Herbicides accomplish control of unwanted vegetation without the soil disturbance associated with mechanical methods of control. Further, because the dead plant material is usually left in place to decay, the impact on habitat structure is delayed and less severe.

The use of herbicides has been the subject of recent controversy concerning potential direct and indirect hazards to wildlife. Specific hazards involving the use of chemicals range from negligible (Bollen et al. 1970 and 1977, Montgomery and Norris 1970) to acute poisoning (Norris 1974).

Although mechanical manipulation of vegetation or the use of prescribed burning have immediate, dramatic impacts on habitat structure and may be used to accomplish the same goals as herbicide treatments, they avoid the controversy over herbicides.

Croplands

The purpose of this treatment is simply to note that croplands occur in the midst of managed rangelands (fig. 38). They are so different in ecological makeup that they require a totally different management viewpoint.

Figure 38.—Croplands occurring amidst managed rangelands are so different in ecological make-up that they require a totally different management viewpoint. (Bureau of Land Management photograph by Robert R. Kindschy)

De Loach (1971:225) said: ". . .the objective of agriculture is to encourage the growth of a foreign organism, a crop, at a high density and to suppress. . .organisms that might compete with it. . . ." Kennedy (1968) suggested that agriculture and conservation are no longer compatible concepts and should be considered separately.

> "When man dug holes here and there and planted a few seeds for his food, ample diversity of species remained, but this resulted in small crop yields both because of competition from other plants (weeds) and because insects, birds, and mammals all took their share of the crop" (Pimentel 1971:212).

In modern agricultural practice in North America, however, large fields are often planted with a single-species. This specialization has resulted from the economic needs and technology of a mechanized society and has created a greatly simplified environment (Pimentel 1971). Such monocultures are basically unstable and lack the checks and balances of a natural, diverse ecosystem. Agricultural crops, therefore, require constant human care (such as cultivation) and control (with insecticides, rodenticides, herbicides, or all three) if a crop is to produce as desired.

Plant and animal communities that surround croplands exert a constant, often negative, influence on production. When native plants and animals use agricultural crops as habitat, they are normally termed pests; however, "Pests exist only in man's own view of nature and their existence results. . .from his. . .resource management practices" (Pimentel 1971:211).

Small, diversified family farms were excellent habitat for wildlife. They provided increased structural diversity, and therefore, increased habitat diversity through a good mix of food, cover, and water within surrounding, rather homogeneous rangelands. The many small, irregular fields with a variety of crops created an abundance of structurally diverse edges; and tillage offered a variety of soil textures for burrowing animals. Uncultivated fence-rows and ditch banks provided strips that not only acted as primary habitat for some species but also provided travel lanes between fields for other species. These situations were ideal for species, such as gopher snakes, California quail, ring-necked pheasant (*Phasianus colchicus*), voles, rabbits, weasels, skunks, and foxes (*Vulpes* spp.).

Replacement of small farms by large farms dependent on mechanization and specialized crop monocultures caused a drastic decline in wildlife habitats within and adjacent to croplands. And, because of the decreased crop stability—increased crop vulnerability—resulting from the greatly simplified "agricultural ecosystem," man is more and more inclined to view native wildlife as actual or potential "pests" to his crops.

The erratic economics of agriculture is considered to be the primary impetus behind increasing crop specialization in North America. In addition, governmental influence on modern agriculture, which has attempted to maintain low-cost food production, has largely made the small, diversified farm uneconomical. Consequently, most have disappeared. In turn, for modern agriculture to survive economically, modifications in farming strategies have been necessary, and the following changes in land use have resulted:

1. Increased specialization of farms (growing fewer crops in larger fields) caused amalgamation of small, individual fields.

2. Increased size of individual farms due to large, specialized corporate farms replacing small, diversified family farms.

3. Increased use of modern machinery that is more easily and more economically operated in large fields.

4. Increased clearing of fence rows to gain more land for agriculture (Shrubb 1970, Van Deusen 1978)—2.6 kilometers (1 mile) of fence row may occupy .2 hectare (.5 acre) (Moore et al. 1967).

5. Increased use of large, sprinkler irrigation systems that eliminate uncultivated irrigation ditches and their banks.

6. Replacement of uncultivated earthen irrigation ditch banks with concrete.

7. Federal aid to farmers through the Agricultural Stabilization and Conservation Service for various types of land "reclamation."

Although these factors reduce habitat for many species of wildlife within agricultural lands (Allen et al. 1973), they also create habitat for a few species, such as the exotic ring-necked pheasant. For example, with specialization, came larger individual fields and, therefore, extensive monocultures. The small, diversified family farms have been replaced by large, specialized corporate farms with modern machinery that can only be utilized efficiently and economically in large, single-product fields.

From the foregoing discussion, it should be recognized that where agricultural crops occur in managed rangelands, they may be primarily considered as being in conflict with most wildlife species. In some cases, these conflicts may be severe, such as heavy grazing by deer on hay crops or by rodent damage to grain crops. But agricultural lands do provide habitats for some game species that are particularly adapted to agricultural conditions—such as the exotic pheasant. In addition, some native species, such as quail and cottontail rabbits, may take advantage of edges created between cropland and rangeland.

Management Tips

ABANDONED HOMESTEADS

When considering historical and wildlife values, it is desirable to retain abandoned homesteads, regardless of their age. Not only do they add character and historical interest to the landscape but they also add wildlife habitat diversity. Although it may be uneconomical to maintain homesteads in a constant state of repair, it costs nothing to allow these habitats to remain—disintegrating slowly and naturally (fig. 39).

Allowing homesteads to disintegrate naturally is in keeping with the USDI Bureau of Land Management Manual 1602—Basic Guidance (1973 : 42C-42C3d), under "Environmental Protection and Enhancement," which states that:

> c. In all land use and program decisions, protection of natural and man-made elements in the environment which have esthetic values of natural beauty, harmony, variety or uniqueness will be fully considered.
>
> d. In all land use and program decisions, protection of natural and man-made elements in the environment which contribute to the cultural heritage of human society, or to human understanding of ecological processes, will be fully considered.

Figure 39.—Although it may be uneconomical to maintain homesteads in a constant state of repair, it costs nothing to allow these habitats to remain — disintegrating slowly and naturally. Once a homestead site has been established and the introduced vegetation, such as trees and shrubs, has become part of the landscape, the site can be planned for and managed as wildlife habitat. (Bureau of Land Management photograph)

> e. If there is no cost involved, ecological, esthetic or human interest values will be protected or enhanced through careful design and execution of Bureau programs. If preservation or enhancement of these values would result in loss of other resource values or increase in program costs, the long range cost is compared to the long range results. Great weight is given to preservation of a wholesome continually productive environment for future generations.

If maintenance of a wooden homestead is a management objective, however, it would be a good idea to refer to the overview article by Rowell et al. (1977) on the preservation of log cabins.

Once a homestead site has been established and the introduced vegetation, such as trees and shrubs, has become part of the landscape, the site can be planned for and managed as wildlife habitat. Moreover, use as wildlife habitat can easily be perpetuated by scheduling the replanting of trees and shrubs to assure maintenance of the habitat over time.

If livestock are to be grazed in the vicinity of an abandoned homestead, it may be advisable to fence the livestock out of the homestead site. Such action not only will greatly prolong the site's value but also will encourage and protect the development of relatively dense vegetation, enhancing the value of the site as wildlife habitat.

It may be wise *not* to show the locations of abandoned homesteads on tourist and recreational maps, thereby eliminating much potential disturbance and vandalism.

Finally, if a management plan includes the alteration of an abandoned homestead, the site should be examined by both a wildlife biologist and a cultural resource specialist (USDI Bureau of Land Management Manual 6231). The value of these abandoned homesteads as wildlife habitat should be added to their historical value as reasons to continue their existence.

ROADS

Banks, soil ridges, and talus-like formations created by road construction form significant wildlife habitats in areas where the habitats that they mimic are naturally lacking. When and where these manmade habitats harbor uncommon wildlife or wildlife of special interest, they can be identified and managed as habitats with planned perpetuation and enhancement. It may also be desirable, under some circumstances, to purposefully create and maintain one or more such habitats in specific locations for specific species of wildlife.

BRIDGES

When possible, bridges should be constructed of concrete, masonry, or rock rather than wood; such bridges have the greatest potential as wildlife habitat. For example, the surface of the pillars and beams can be roughened so swallows will have an easier time attaching their nests and bats may gain a better purchase when roosting. Beams can have built-in ledges or bolted on planks to form nesting platforms for birds. Nesting boxes can be installed under bridges to further increase bird use. Bridges can also be designed with deep "crevices" so that bats can raise their young (fig. 40).

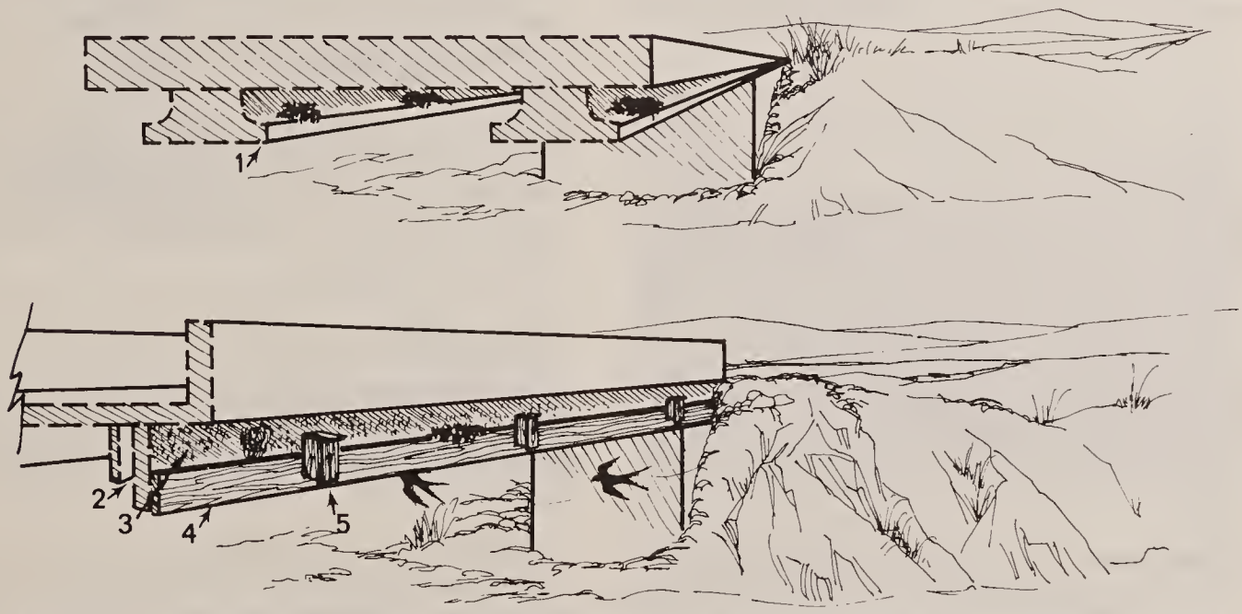

Figure 40.—Concrete bridges can be designed to enhance their potential as wildlife habitat: (1) expanded beams for nest construction, (2) manmade crevice in which bats can roost and rear young, (3) roughened concrete to aid nest construction by some species of birds, (4) wooden plank to create a platform on which birds can nest, and (5) bird boxes to enhance use by a variety of birds.

If a bridge with well-established wildlife use is to be replaced, it may be desirable to construct the new bridge alongside of the old one, retaining the old bridge as wildlife habitat (see fig. 23). The new bridge can be constructed with the above mentioned modifications to increase potential wildlife use. Thus, unusual wildlife habitats can be increased and maintained over time.

ROCK WALLS, ROCK JACKS, ROCK CRIBS, AND SHEEPHERDER MONUMENTS

If rock walls, rock jacks, rock cribs, and sheepherder monuments are to be constructed, wildlife values can be enhanced by using large rocks, 30 to 60 cm (12 to 24 in) in diameter. Wooden posts used in the construction of rock jacks and wooden rock cribs are used as perches by birds—particularly raptors (Marion and Ryder 1975). Rock walls and wire rock cribs, on the other hand, do not usually have wooden posts as part of their structure; but long wooden posts can be wired to a rock crib or placed inside of a crib and held in place with the rocks (fig. 41). Wooden posts can also be wired to steel posts or interspersed with steel posts along a fence, but they should be taller than the steel posts. Further, a wooden crosspiece secured to the top of a wooden post may enhance raptor use (fig. 42).

Figure 41.—Long wooden posts, but shorter than these old telephone poles, can be placed inside wire rock cribs and held in place with the rocks. Such posts can be used as perches by birds—particularly raptors—which will add to a rock crib's value as wildlife habitat. (Chris Maser photograph)

Wildlife use can be augmented by interspersing rock jacks on a fence stabilized primarily by rock cribs and vice versa and by the strategic placement of wooden perching posts. Bird boxes attached to fences can provide additional nesting and roosting places for birds and shelter for small mammals. The tops of these boxes may represent roosting sites for common nighthawks (*Chordeiles minor*) and sunning places for lizards (fig. 43). These structures add cover and form dispersal routes for some species of wildlife.

If a fence is to be removed, therefore, established wildlife-habitat values can be retained over long periods by leaving the rock structures intact.

WOODEN CORRALS AND FENCES WITH WOODEN POSTS

Abandoned wooden corrals, if left intact, will be used by wildlife for years as perches and for shade.

If a fence with wooden posts is to be replaced by an all-steel fence, then some of the wooden posts can be incorporated into the new fence. If a fence is to be removed and not replaced, however, then some of the wooden posts could be left intact. In this way they will continue to provide perches for raptors and other birds and shade for small ground-dwelling animals.

POWERLINES

Particular attention should be given to planning powerline routes that will minimize impacts on critical habitats, especially riparian zones.

Closure and non-maintenance of all possible roads associated with powerlines may contribute to the welfare of wildlife, but this will reduce human-wildlife contacts. On the other hand, if roads must be open or maintained, then closure to other than official use would be of some value to wildlife.

Figure 42.—Wooden posts can be interspaced along all-steel fences to enhance the habitat for perching birds. In addition, if the wooden posts are taller than the steel posts and have a wooden cross-piece secured to their tops, they may enhance use of the surrounding habitat by raptors.

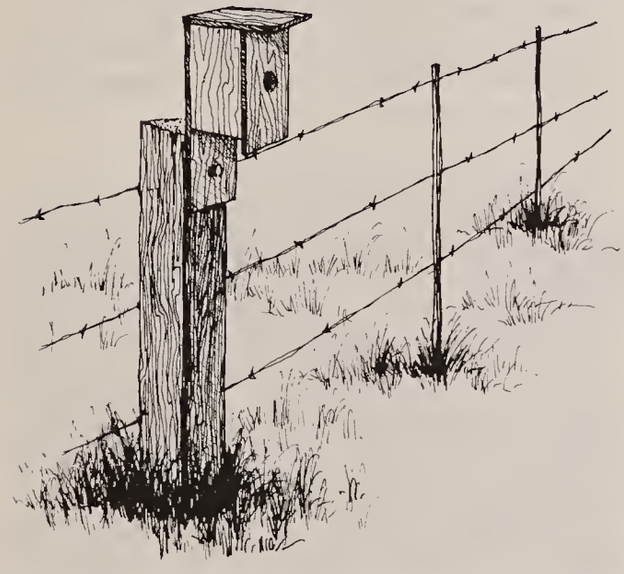

Figure 43.—Bird boxes attached to fences can provide additional nesting and roosting places for birds and shelter for small mammals. The tops of these boxes may represent roosting sites for common nighthawks (*Chordeiles minor*) and sunning places for lizards.

If a right-of-way goes through an extensive area of similar habitat, such as a juniper woodland, it may be advantageous to wildlife if the right-of-way is made wide enough and of such a configuration so as to maximize wildlife diversity and to maintain self-sustaining populations of wildlife within its boundaries (see fig. 37). Conversely, a right-of-way that cannot be diverted around but must go through scarce habitat—habitat that occupies a small percent of the surrounding landscape—should be kept as narrow as possible.

When trees, such as juniper (*Juniperus* spp.), are killed, cut down or chained, leaving some dead, down woody debris will enhance habitat diversity and, therefore, wildlife species diversity (Maser and Gashwiler 1978).

Although all powerlines, poles, and towers should be made safe for birds, when a raptor nests within a tower in a way that a hazard is created, the nest should be moved, intact, to a new locality within the tower if possible and should be securely fastened. This action will remove the hazard and will allow the birds to successfully rear their young (Wayne Elmore, personal communication 1978). In addition, construction of nesting platforms on powerline towers has the potential of increasing raptor nesting habitat and reproductive success.

With careful planning and land-use management, powerline rights-of-way have the potential for creating wildlife habitats in

specific localities. They may be used not only to increase habitat diversity but also to increase the populations of particular species of wildlife.

CROPLANDS

Proposed cropland development within managed rangeland should be evaluated for potential wildlife conflicts prior to its installation. The initial plan should provide a full analysis of those conflicts and how they are to be resolved. Most cropland developments within rangelands will be detrimental to native species because of the extreme alteration in their habitats (fig. 44). And species that will use such habitats are apt to become "pests."

Agricultural activities may provide a niche for exotic species, such as ring-necked pheasants. Their welfare can be enhanced by intentionally creating brush rows between fields, natural areas along irrigation ditches, etc.

Figure 44.—Most cropland developments within rangelands will be detrimental to native species of wildlife because of the extreme alteration in their habitats. As a result, those wildlife species that will use cropland habitats are apt to become "pests." (Bureau of Land Management photograph by M. Hurd)

Summary

Manmade structures, such as homesteads, bridges, and rock walls, blend into the rangelands of the Great Basin with the passage of time. They create habitat diversity in large expanses of otherwise relatively homogeneous landscapes, thereby increasing the diversity of wildlife (fig. 45). And they may be esthetically pleasing.

Manmade structures, when obviously "old" or of a past era, come to be considered as part of our national heritage and by law may be preserved for the reflective consideration and enjoyment of the public. These structures, when considered as habitat, also become part of our natural heritage in that they bring man closer to wildlife.

The importance of manmade structures as habitats for wildlife is just being perceived in land management. And it is possible, with careful planning, to manage such structures simultaneously for the enhancement and perpetuation of their cultural and their wildlife values. In turn, this will provide greater enjoyment for the land owners—the public.

Figure 45.—Manmade structures, such as homesteads, blend into the rangelands of the Great Basin with the passage of time. In so doing, they create habitat diversity in large expanses of otherwise relatively homogeneous landscapes, thereby increasing the diversity of wildlife. Note: The grassy area immediately above the house is a spring — the homestead's water supply. (Chris Maser photograph)

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Appendix 1

Generalized response of terrestrial species of vertebrate wildlife to manmade habitats.

Legend: 0 = generally neutral response
— = generally negative response
+ = generally positive response

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
Amphibians							
long-toed salamander	*Ambystoma macrodactylum*	+	0	+	0	0	—
Great Basin spadefoot	*Scaphiopus intermontanus*	+	—	+	0	—	—
western toad	*Bufo boreas*	+	0	+	0	—	—
Woodhouse toad	*Bufo woodhousei*	+	0	+	0	—	—
Pacific tree frog	*Hyla regilla*	+	—	+	0	—	—
spotted frog	*Rana pretiosa*	+	0	0	0	0	0
leopard frog	*Rana pipiens*	+	0	0	0	0	—
bullfrog	*Rana catesbeiana*	+	0	0	0	0	0
Reptiles							
collard lizard	*Crotaphytus collaris*	—	—	—	0	—	—
leopard lizard	*Crotaphytus wislizeni*	—	—	—	+	—	—
western fence lizard	*Sceloporus occidentalis*	0	—	+	—	—	—
sagebrush lizard	*Sceloporus graciosus*	0	0	0	0	—	—
side-blotched lizard	*Uta stansburiana*	—	—	+	0	—	—
desert horned lizard	*Phrynosoma platyrhinos*	0	—	0	0	0	—
short-horned lizard	*Phrynosoma douglassi*	0	—	0	0	0	—
western skink	*Eumeces skiltonianus*	+	—	+	+	—	—
western whiptail	*Cnemidophorus tigris*	+	—	+	+	—	—
rubber boa	*Charina bottae*	+	—	+	+	—	—
yellow-bellied racer	*Coluber constrictor*	+	—	+	+	—	—
striped whipsnake	*Masticophis taeniatus*	+	—	+	+	—	—
gopher snake	*Pituophis melanoleucus*	+	—	+	+	—	—
common garter snake	*Thamnophis sirtalis*	+	—	+	0	—	—
wandering garter snake	*Thamnophis elegans*	+	—	+	0	—	—
western ground snake	*Sonora semiannulata*	+	—	+	0	—	—
night snake	*Hypsiglena torquata*	+	—	+	+	—	—
western rattlesnake	*Crotalus viridis*	+	—	+	+	—	—
Birds							
common loon	*Gavia immer*	—	0	0	0	0	0
red-necked grebe	*Podiceps grisegena*	—	0	0	0	0	0
horned grebe	*Podiceps auritus*	—	0	0	0	0	0

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
eared grebe	*Podiceps nigricollis*	—	0	0	0	0	0
western grebe	*Aechmophorus occidentalis*	—	0	0	0	0	0
pied-billed grebe	*Podilymbus podiceps*	—	0	0	0	0	0
white pelican	*Pelecanus erythrorhynchos*	—	0	0	0	0	—
double-crested cormorant	*Phalacrocorax auritus*	—	0	0	0	0	0
great blue heron	*Ardea herodias*	+	0	0	0	0	—
green heron	*Butorides virescens*	+	0	0	0	0	0
cattle egret	*Bubulcus ibis*	+	0	0	0	0	—
common egret	*Casmerodius albus*	+	0	0	0	0	—
black-crowned night heron	*Nycticorax nycticorax*	+	0	0	0	0	0
American bittern	*Botaurus lentiginosus*	+	0	0	0	0	0
least bittern	*Ixobrychus exilis*	+	0	0	0	0	0
white-faced ibis	*Plegadis chihi*	+	0	0	0	0	0
whistling swan	*Olor columbianus*	+	0	0	0	0	—
Canada goose	*Branta canadensis*	+	0	0	0	0	—
white-fronted goose	*Anser albifrons*	+	0	0	0	0	—
snow goose	*Chen caerulescens*	+	0	0	0	0	—
Ross' goose	*Chen rossii*	+	0	0	0	0	—
mallard	*Anas platyrhynchos*	+	0	0	0	0	—
gadwall	*Anas strepera*	+	0	0	0	0	—
pintail	*Anas acuta*	+	0	0	0	0	—
green-winged teal	*Anas crecca*	+	0	0	0	0	—
blue-winged teal	*Anas discors*	+	0	0	0	0	—
cinnamon teal	*Anas cyanoptera*	+	0	0	0	0	0
American wigeon	*Anas americana*	+	0	0	0	0	—
northern shoveler	*Anas clypeata*	+	0	0	0	0	—
wood duck	*Aix sponsa*	+	0	0	0	0	0
redhead	*Aythya americana*	+	0	0	0	0	0
ring-necked duck	*Aythya collaris*	+	0	0	0	0	—
canvasback	*Aythya valisineria*	+	0	0	0	0	0
greater scaup	*Aythya marila*	+	0	0	0	0	0
lesser scaup	*Aythya affinis*	+	0	0	0	0	0
common goldeneye	*Bucephala clangula*	+	0	0	0	0	0
Barrow's goldeneye	*Bucephala islandica*	+	0	0	0	0	0
bufflehead	*Bucephala albeola*	+	0	0	0	0	0
oldsquaw	*Clangula hyemalis*	+	0	0	0	0	0
King eider	*Somateria spectabilis*	+	0	0	0	0	0
ruddy duck	*Oxyura jamaicensis*	+	0	0	0	0	0
hooded merganser	*Lophodytes cucullatus*	+	0	0	0	0	0

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
common merganser	*Mergus merganser*	+	0	0	0	0	0
red-breasted merganser	*Mergus serrator*	+	0	0	0	0	0
turkey vulture	*Cathartes aura*	+	+	+	+	+	—
goshawk	*Accipiter gentilis*	+	0	0	0	0	0
sharp-shinned hawk	*Accipiter striatus*	+	0	0	0	0	0
Cooper's hawk	*Accipiter cooperii*	+	0	0	0	0	0
red-tailed hawk	*Buteo jamaicensis*	+	+	+	+	—	—
Swainson's hawk	*Buteo swainsoni*	+	+	+	+	—	—
rough-legged hawk	*Buteo lagopus*	+	+	+	+	—	—
ferruginous hawk	*Buteo regalis*	+	—	+	+	—	—
golden eagle	*Aquila chrysaetos*	+	+	+	+	—	—
bald eagle	*Haliaeetus leucocephalus*	+	+	+	+	—	—
marsh hawk	*Circus cyaneus*	+	—	+	+	—	—
osprey	*Pandion haliaetus*	+	0	0	0	0	0
prairie falcon	*Falco mexicanus*	+	0	+	+	—	—
peregrine	*Falco peregrinus*	+	0	+	+	—	—
merlin	*Falco columbarius*	+	0	+	+	—	—
American kestrel	*Falco sparverius*	+	0	+	+	—	—
blue grouse	*Dendragapus obscurus*	+	0	+	0	0	—
ruffed grouse	*Bonasa umbellus*	+	0	0	0	0	—
sage grouse	*Centrocercus urophasianus*	+	0	0	0	0	—
California quail	*Lophortyx californicus*	+	0	+	+	—	—
mountain quail	*Oreortyx pictus*	+	0	0	0	—	—
chukar	*Alectoris chukar*	+	0	+	0	0	—
gray partridge	*Perdix perdix*	+	0	0	0	—	—
ring-necked pheasant	*Phasianus colchicus*	+	—	—	0	—	—
sandhill crane	*Grus canadensis*	+	0	0	0	—	—
Virginia rail	*Rallus limicola*	+	0	0	0	0	0
sora	*Porzana carolina*	+	0	0	0	0	0
American coot	*Fulica americana*	+	0	0	0	—	—
snowy plover	*Charadrius alexandrinus*	+	0	0	0	0	—
killdeer	*Charadrius vociferus*	+	0	0	0	0	—
mountain plover	*Charadrius montanus*	+	0	0	0	0	—
common snipe	*Capella gallinago*	+	0	0	0	0	—
long-billed curlew	*Numenius americanus*	—	0	+	0	0	—
semi-palmated plover	*Charadrius semipalmatus*	+	0	0	0	0	—
spotted sandpiper	*Actitis macularia*	+	0	0	0	0	—
solitary sandpiper	*Tringa solitaria*	+	0	0	0	0	—
greater yellowlegs	*Tringa melanoleuca*	+	0	0	0	0	—

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
lesser yellowlegs	*Tringa flavipes*	+	0	0	0	0	—
willet	*Catoptrophorus semipalmatus*	+	0	0	0	0	—
pectoral sandpiper	*Calidris melanotos*	+	0	0	0	0	—
Baird's sandpiper	*Calidris bairdii*	+	0	0	0	0	—
least sandpiper	*Calidris minutilla*	+	0	0	0	0	—
western sandpiper	*Calidris mauri*	+	0	0	0	0	—
long-billed dowitcher	*Limnodromus scolopaceus*	+	0	0	0	0	—
marbled godwit	*Limosa fedoa*	+	0	0	0	0	—
American avocet	*Recurvirostra americana*	+	0	0	0	0	—
black-necked stilt	*Himantopus mexicanus*	+	0	0	0	0	—
Wilson's phalarope	*Steganopus tricolor*	+	0	0	0	0	0
northern phalarope	*Lobipes lobatus*	+	0	0	0	0	0
herring gull	*Larus thayeri*	+	0	0	0	0	—
California gull	*Larus californicus*	+	0	0	0	0	—
ring-billed gull	*Larus delawarensis*	+	0	0	0	0	—
Franklin's gull	*Larus pipixcan*	+	0	0	0	0	—
Bonaparte's gull	*Larus philadelphia*	+	0	0	0	0	—
Forster's tern	*Sterna forsteri*	+	0	0	0	0	0
Caspian tern	*Hydroprogne caspia*	+	0	0	0	0	0
black tern	*Chlidonias niger*	+	0	0	0	0	0
rock dove	*Columba livia*	+	+	+	0	0	—
mourning dove	*Zenaida macroura*	+	0	0	0	0	—
yellow-billed cuckoo	*Coccyzus americanus*	+	0	0	0	0	0
barn own	*Tyto alba*	+	—	+	+	0	—
screech owl	*Otus asio*	+	—	+	+	0	—
flammulated owl	*Otus flammeolus*	+	—	+	+	0	—
great horned owl	*Bubo virginianus*	+	—	+	+	+	—
pygmy owl	*Glaucidium gnoma*	+	—	+	+	+	—
burrowing owl	*Athene cunicularia*	+	—	+	+	0	—
long-eared owl	*Asio otus*	+	—	+	+	0	—
short-eared owl	*Asio flammeus*	+	0	+	+	0	—
saw-whet owl	*Aegolius acadicus*	+	0	0	+	0	—
poorwill	*Phalaenoptilus nuttallii*	+	0	+	0	0	—
common nighthawk	*Chordeiles minor*	+	+	+	0	0	—
black swift	*Cypseloides niger*	+	0	+	0	0	—
Vaux's swift	*Chaetura vauxi*	+	0	+	0	0	—
white-throated swift	*Aeronautes saxatalis*	+	0	+	0	0	—
black-chinned hummingbird	*Archilochus alexandri*	+	0	0	0	0	0
Anna's hummingbird	*Calypte anna*	+	0	0	0	0	0

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
broad-tailed hummingbird	*Selasphorus platycercus*	+	0	0	0	0	0
rufous hummingbird	*Selasphorus rufus*	+	0	0	0	0	0
calliope hummingbird	*Stellula calliope*	+	0	0	0	0	0
belted kingfisher	*Megaceryle alcyon*	+	—	0	0	0	0
common flicker	*Colaptes auratus*	+	—	0	—	0	0
Lewis' woodpecker	*Asyndesmus lewis*	+	—	0	—	0	0
yellow-bellied sapsucker	*Sphyrapicus varius*	+	0	0	0	0	0
Williamson's sapsucker	*Sphyrapicus thyroideus*	+	0	0	0	0	0
hairy woodpecker	*Dendrocopos villosus*	+	0	0	0	0	0
downy woodpecker	*Dendrocopos pubescens*	+	0	0	0	0	0
white-headed woodpecker	*Dendrocopos albolarvatus*	+	0	0	0	0	0
eastern kingbird	*Tyrannus tyrannus*	+	0	0	0	0	—
western kingbird	*Tyrannus verticalis*	+	—	+	0	0	—
ash-throated flycatcher	*Myiarchus cinerascens*	+	0	+	+	0	—
Say's phoebe	*Sayornis saya*	+	+	+	+	0	0
willow flycatcher	*Empidonax traillii*	+	0	0	0	0	—
Hammond's flycatcher	*Empidonax hammondii*	+	0	0	0	0	—
gray flycatcher	*Empidonax wrightii*	+	+	+	+	0	—
western flycatcher	*Empidonax difficilis*	+	0	0	0	0	—
western wood pewee	*Contopus sordidulus*	+	0	0	0	0	—
olive-sided flycatcher	*Nuttallornis borealis*	+	0	0	0	0	—
horned lark	*Eremphila alpestris*	0	+	+	0	0	—
violet-green swallow	*Tachycineta thalassina*	+	0	0	0	0	—
tree swallow	*Iridoprocne bicolor*	+	0	0	0	0	—
bank swallow	*Riparia riparia*	+	+	0	0	0	—
rough-winged swallow	*Stelgidopteryx ruficollis*	+	+	0	0	0	—
barn swallow	*Hirundo rustica*	+	+	0	0	0	—
cliff swallow	*Petrochelidon pyrrhonota*	+	+	0	0	0	—
gray jay	*Perisoreus canadensis*	+	0	0	0	0	—
Steller's jay	*Cyanocitta stelleri*	+	0	0	0	0	—
scrub jay	*Aphelocoma coerulescens*	+	0	+	0	0	—
black-billed magpie	*Pica pica*	+	+	+	+	0	—
common raven	*Corvus corax*	+	+	+	+	+	—
common crow	*Corvus brachyrhynchos*	+	0	+	0	0	—
pinyon jay	*Gymnorhinus cyanocephalus*	+	0	+	+	0	—
Clark's nutcracker	*Nucifraga columbiana*	+	0	0	0	0	0
black-capped chickadee	*Parus atricapillus*	+	0	0	0	0	0
mountain chickadee	*Parus gambeli*	+	0	0	0	0	0
bushtit	*Psaltriparus minimus*	+	0	0	0	0	0

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
white-breasted nuthatch	*Sitta carolinensis*	+	0	0	0	0	0
red-breasted nuthatch	*Sitta canadensis*	+	0	0	0	0	0
brown creeper	*Certhia familiaris*	+	0	0	0	0	0
dipper	*Cinclus mexicanus*	+	+	0	0	0	0
house wren	*Troglodytes aedon*	+	+	+	0	0	0
winter wren	*Troglodytes troglodytes*	+	+	0	0	0	0
long-billed marsh wren	*Telmatodytes palustris*	+	0	0	0	0	0
canyon wren	*Catherpes mexicanus*	+	+	+	0	0	0
rock wren	*Salpinctes obsoletus*	+	+	+	0	0	0
gray catbird	*Dumetella carolinensis*	+	0	0	0	0	0
brown thrasher	*Toxostoma rufum*	+	0	0	0	0	—
sage thrasher	*Oreoscoptes montanus*	+	0	+	0	0	—
American robin	*Turdus migratorius*	+	0	+	0	0	—
varied thrush	*Ixoreus naevius*	+	0	0	0	0	—
hermit thrush	*Catharus guttatus*	+	0	0	0	0	0
Swainson's thrush	*Catharus ustulatus*	+	0	0	0	0	0
veery	*Catharus fuscescens*	+	0	0	0	0	0
western bluebird	*Sialia mexicana*	+	0	+	+	0	—
mountain bluebird	*Sialia currucoides*	+	0	+	+	0	—
Townsend's solitaire	*Myadestes townsendi*	+	0	+	0	0	0
blue-gray gnatcatcher	*Popioptila caerulea*	+	0	+	0	0	0
water pipit	*Anthus spinoletta*	+	+	+	0	0	—
bohemian waxwing	*Bombycilla garrulus*	+	0	0	0	0	0
cedar waxwing	*Bombycilla cedrorum*	+	0	0	0	0	0
northern shrike	*Lanius excubitor*	+	+	+	+	0	0
loggerhead shrike	*Lanius ludovicianus*	+	+	+	+	0	0
starling	*Sturnus vulgaris*	+	0	0	0	0	+
solitary vireo	*Vireo solitarius*	+	0	0	0	0	0
red-eyed vireo	*Vireo olivaceus*	+	0	0	0	0	0
warbling vireo	*Vireo gilvus*	+	0	0	0	0	0
orange-crowned warbler	*Vermivora celata*	+	0	0	0	0	0
yellow warbler	*Dendroica petechia*	+	0	0	0	0	0
yellow-rumped warbler	*Dendroica coronata*	+	0	0	0	0	0
black-throated gray warbler	*Dendroica nigrescens*	+	0	0	0	0	0
Townsend's warbler	*Dendroica townsendi*	+	0	0	0	0	0
ovenbird	*Seiurus aurocapillus*	+	0	0	0	0	0
MacGillivray's warbler	*Oporornis tolmiei*	+	0	0	0	0	0
common yellowthroat	*Geothlypis trichas*	+	0	0	0	0	0
yellow-breasted chat	*Icteria virens*	+	0	0	0	0	0

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
Wilson's warbler	*Wilsonia pusilla*	+	0	0	0	0	0
American redstart	*Setophaga ruticilla*	+	0	0	0	0	0
house sparrow	*Passer domesticus*	+	+	+	+	0	—
bobolink	*Dolichonyx oryzivorus*	+	0	0	0	0	—
western meadowlark	*Sturnella neglecta*	+	0	+	+	0	—
yellow-headed blackbird	*Xanthocephalus xanthocephalus*	+	0	0	0	0	—
red-winged blackbird	*Agelaius phoeniceus*	+	0	0	0	0	—
northern oriole	*Icterus galbula*	+	0	0	0	0	0
Brewer's blackbird	*Euphagus cyanocephalus*	+	0	0	0	0	—
brown-headed cowbird	*Molothrus ater*	+	0	0	0	0	—
western tanager	*Piranga ludoviciana*	+	0	0	0	0	0
rose-breasted grosbeak	*Pheucticus ludovicianus*	+	0	0	0	0	0
black-headed grosbeak	*Pheucticus melanocephalus*	+	0	0	0	0	0
indigo bunting	*Passerina cyanea*	+	0	0	0	0	0
lazuli bunting	*Passerina amoena*	+	0	0	0	0	0
evening grosbeak	*Hesperiphona vespertina*	+	0	0	0	0	0
purple finch	*Carpodacus purpureus*	+	0	0	0	0	—
Cassin's finch	*Carpodacus cassinii*	+	0	0	0	0	—
house finch	*Carpodacus mexicanus*	+	0	0	0	0	—
common redpol	*Acanthis flammea*	+	0	0	0	0	—
pine siskin	*Spinus pinus*	+	0	0	0	0	—
American goldfinch	*Spinus tristis*	+	0	0	0	0	—
lesser goldfinch	*Spinus psaltria*	+	0	0	0	0	—
green-tailed towhee	*Chlorura chlorura*	+	0	0	0	0	—
rufous-sided towhee	*Pipilo erythrophthalmus*	+	0	0	0	0	—
savannah sparrow	*Passerculus sandwichensis*	+	+	+	0	0	—
grasshopper sparrow	*Ammodramus savannarum*	+	+	+	0	0	—
vesper sparrow	*Pooecetes gramineus*	+	+	+	0	0	—
lark sparrow	*Chondestes grammacus*	+	0	+	0	0	—
sage sparrow	*Amphispiza belli*	+	0	+	0	0	—
dark-eyed junco	*Junco hyemalis*	+	0	0	0	0	—
tree sparrow	*Spizella arborea*	+	0	0	0	0	—
chipping sparrow	*Spizella passerina*	+	0	0	0	0	—
Brewer's sparrow	*Spizella breweri*	+	0	+	0	0	—
white-crowned sparrow	*Zonotrichia leucophrys*	+	0	+	0	0	—
golden-crowned sparrow	*Zonotrichia atricapilla*	+	0	+	0	0	—
fox sparrow	*Passerella iliaca*	+	0	0	0	0	—
Lincoln's sparrow	*Melospiza lincolnii*	+	0	0	0	0	—
song sparrow	*Melospiza melodia*	+	0	0	0	0	—

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
Lapland longspur	*Calcarius lapponicus*	+	0	+	0	0	—
snow bunting	*Plectrophenax nivalis*	+	0	+	0	0	—
Mammals							
Malheur shrew	*Sorex preblei*	+	—	0	0	—	—
wandering shrew	*Sorex vagrans*	+	—	+	+	—	—
Merriam shrew	*Sorex merriami*	+	—	+	+	—	—
little brown myotis	*Myotis lucifugus*	+	+	0	0	0	0
Yuma myotis	*Myotis yumanensis*	+	+	0	0	0	0
long-eared myotis	*Myotis evotis*	+	+	0	0	0	0
fringed myotis	*Myotis thysanodes*	+	+	0	0	0	0
long-legged myotis	*Myotis volans*	+	+	0	0	0	0
California myotis	*Myotis californicus*	+	+	0	0	0	0
small-footed myotis	*Myotis leibi*	+	+	0	0	0	0
silver-haired bat	*Lasionycteris noctivagans*	+	+	0	0	0	0
western pipistrelle	*Pipistrellus hesperus*	+	+	0	0	0	0
big brown bat	*Eptesicus fuscus*	+	+	0	0	0	0
hoary bat	*Lasiurus cinereus*	+	0	0	0	0	—
spotted bat	*Euderma maculata*	0	0	0	0	0	—
western big-eared bat	*Plecotus townsendi*	+	+	0	0	0	0
pallid bat	*Antrozous pallidus*	+	+	0	0	0	0
pygmy rabbit	*Sylvilagus idahoensis*	+	—	+	+	—	—
mountain cottontail	*Sylvilagus nuttalli*	+	—	+	+	—	—
white-tailed jackrabbit	*Lepus townsendi*	+	—	0	0	—	—
black-tailed jackrabbit	*Lepus californicus*	+	—	0	0	—	—
least chipmunk	*Eutamias minimus*	+	—	+	+	—	—
yellow-pine chipmunk	*Eutamias amoenus*	+	—	+	+	0	—
yellow-bellied marmot	*Marmota flaviventris*	+	—	+	+	0	—
antelope ground squirrel	*Ammospermophilus leucurus*	0	—	0	0	—	—
Townsend ground squirrel	*Spermophilus townsendi*	+	—	+	+	—	—
Richardson ground squirrel	*Spermophilus richardsoni*	+	—	+	+	—	—
Belding ground squirrel	*Spermophilus beldingi*	+	—	+	+	—	—
mantled ground squirrel	*Spermophilus lateralis*	+	+	+	+	0	0
Townsend pocket gopher	*Thomomys townsendi*	+	+	0	0	+	—
northern pocket gopher	*Thomomys talpoides*	+	+	0	0	+	—
little pocket mouse	*Perognathus longimembris*	0	—	0	0	—	—
Great Basin pocket mouse	*Perognathus parvus*	+	—	0	0	+	—
dark kangaroo mouse	*Microdipodops megacephalus*	0	—	0	0	—	—
Ord kangaroo rat	*Dipodomys ordi*	+	+	0	0	0	—

Appendix 1 (continued)

Wildlife species		Abandoned homesteads	Roads and bridges	Rock walls, jacks, cribs, and monuments	Wood corrals and fences	Powerlines	Croplands
Common name	**Scientific name**						
chisel-toothed kangaroo rat	*Dipodomys microps*	+	+	0	0	0	—
beaver	*Castor canadensis*	—	—	0	0	—	—
western harvest mouse	*Reithrodontomys megalotis*	+	—	+	0	+	—
canyon mouse	*Peromyscus crinitus*	0	0	+	0	—	—
deer mouse	*Peromyscus maniculatus*	+	—	+	+	0	—
northern grasshopper mouse	*Onychomys leucogaster*	+	—	0	0	—	—
desert woodrat	*Neotoma lepida*	+	—	+	+	0	—
bushy-tailed woodrat	*Neotoma cinerea*	+	—	+	+	0	—
montane vole	*Microtus montanus*	+	—	0	0	+	—
long-tailed vole	*Microtus longicaudus*	+	—	0	0	+	—
sage vole	*Lagurus curtatus*	0	+	+	0	—	—
muskrat	*Ondatra zibethicus*	—	0	0	0	0	—
western jumping mouse	*Zapus princeps*	+	—	0	0	—	—
porcupine	*Erethizon dorsatum*	+	—	—	0	—	—
coyote	*Canis latrans*	+	—	—	0	—	—
red fox	*Vulpes vulpes*	+	—	+	+	+	—
kit fox	*Vulpes macrotis*	+	—	+	+	+	—
raccoon	*Procyon lotor*	+	—	+	+	—	—
long-tailed weasel	*Mustela frenata*	+	—	+	+	—	—
mink	*Mustela vison*	+	—	+	0	—	—
badger	*Taxidea taxus*	+	—	+	+	+	—
spotted skunk	*Spilogale putorius*	+	—	+	+	—	—
striped skunk	*Mephitis mephitis*	+	—	+	+	—	—
river otter	*Lutra canadensis*	0	—	0	0	—	—
cougar	*Felis concolor*	+	—	0	0	—	—
bobcat	*Lynx rufus*	+	—	—	0	—	—
mule deer	*Odocoileus hemionus*	+	—	—	—	—	—
pronghorn	*Antilocapra americana*	—	—	—	—	—	—
bighorn sheep	*Ovis canadensis*	—	—	—	—	—	—

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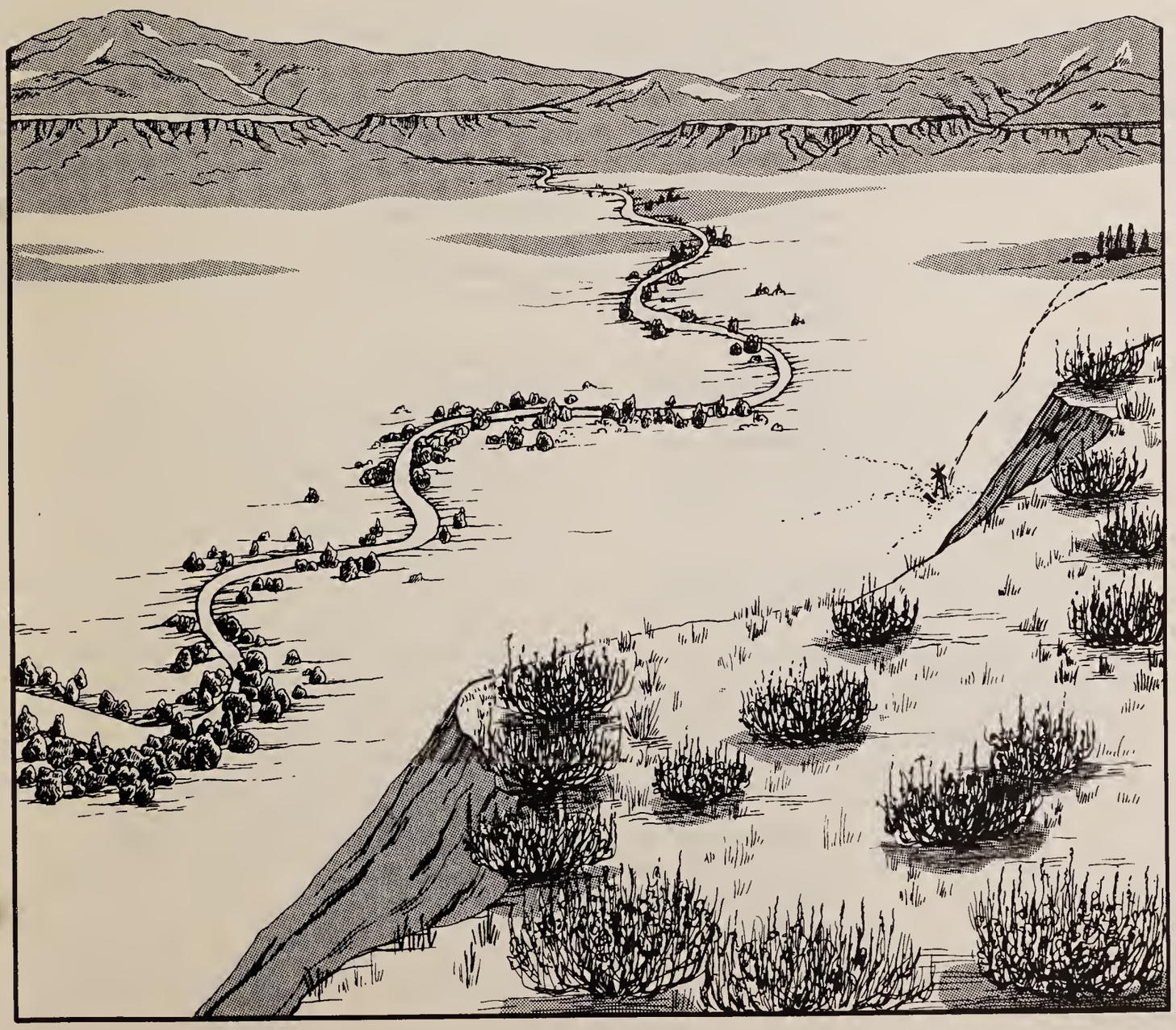
Wildlife Habitats in Managed Rangelands — The Great Basin of Southeastern Oregon

Management Practices and Options

Frederick C. Hall



SPECIAL EDITION, MARCH 1986

Abstract

Management practices and options to provide habitat for wildlife in the Great Basin of southeastern Oregon deal with both vegetation treatment and protection, livestock management, maintenance or distribution of water developments, protection of wildlife areas through road closures or fencing, and direct manipulation of wildlife through hunting, trapping, or other means.

This chapter deals primarily with livestock management in relationship to wildlife and wildlife habitat. Included are discussions of ecological status (range condition), livestock management, multiple-use options for each species featured in previous chapters (trout, sage grouse, pronghorn, mule deer, and bighorn sheep), and diversity.

Keywords: Wildlife habitat management, range management, livestock, Oregon (Great Basin), Great Basin—Oregon, series (Great Basin habitats).

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This publication is part of the series **Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon.** The purpose of this series is to provide a range manager with the necessary information on wildlife and its relationship to habitat conditions in managed rangelands to make fully informed decisions.

The information in this series is specific to the Great Basin of southeastern Oregon and is generally applicable to the shrub-steppe areas of the Western United States. The principles and processes described, however, are generally applicable to all managed rangelands. The purpose of the series is to provide specific information for a particular area and in doing so to develop a process for considering the welfare of wildlife when range management decisions are made.

The series is composed of 14 separate publications designed to form a comprehensive whole. Although each part is an independent treatment of a specific subject, when combined in sequence, the individual parts are as chapters in a book.

A list of the publications in the series and their final organization is shown on the inside back cover of this publication.

Wildlife Habitats in Managed Rangelands—The Great Basin of Southeastern Oregon is a cooperative effort of the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, and the United States Department of the Interior, Bureau of Land Management.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

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Introduction

Management practices and options to provide habitat for wildlife in the Great Basin of southeastern Oregon deal with both vegetation treatment and protection, livestock management, maintenance or distribution of water developments, protection of wildlife areas through road closures or fencing, and direct manipulation of wildlife through hunting, trapping, or other means.

The degree of emphasis given to wildlife objectives must be clearly defined. If wildlife are of major concern to managers, livestock grazing is used to help produce a desired habitat condition. More commonly, wildlife targets are among several objectives to be produced from the same land base under the multiple-use philosophy of land management. Tradeoffs must be made between maximum production of livestock and the best possible wildlife habitat conditions.

Objectives may be stated for individual wildlife species (featured species management), for maintenance of a diversity of species (species richness management), or for a combination of the two (Maser and Thomas 1983).

This chapter deals primarily with livestock management in relation to wildlife and wildlife habitat. Included are discussions of ecological status (range condition), livestock management, multiple-use options for each species featured in previous chapters (trout, sage grouse, pronghorn, mule deer, and bighorn sheep[1]). The chapter concludes with a discussion of diversity.

Ecological Status

Ecological status compares vegetation currently on a site with the vegetation that would occur if there were no fire or livestock grazing. The Society for Range Management (Range Inventory Standardization Committee 1983) defined ecological status as "the present state of vegetation and soil protection of an ecological site in relation to the potential natural community." Close livestock grazing often causes current vegetation to be different from the PNC.

This concept is based on the PNC (potential natural community) that will occupy a specific site in the absence of fire or livestock grazing. When livestock graze, they forage first on the more palatable plant species. If these plants are closely eaten during active growth, their ability to grow and reproduce is seriously reduced. They eventually die, which results in a change of species in the plant community and a general decrease in forage production (fig. 1). Such changes are called range trend; a change away from the PNC is termed "downward trend," which is usually caused by close grazing; a change toward natural potential, called "upward trend," results when livestock are managed so that they graze in a way that allows adequate growth and reproduction of palatable plants (Range Inventory Standardization Committee 1983).

Figure 1.—Effects of livestock grazing on low sagebrush/wheatgrass plant community. Compare the potential natural plant community (left of fence) with the midseral stage (right of fence). Livestock overgrazed wheatgrass and cause it to decrease in density, which resulted in decreased herbage production.

[1]Common and scientific names are listed in the appendix.

The degree of change from the PNC is commonly identified by four condition classes: PNC, late seral, midseral, and early seral (Range Inventory Standardization Committee 1983). Potential natural community occurs when there are no significant changes caused by grazing. Late seral indicates that livestock have caused some change in the plant community and some reduction in forage production. Midseral indicates a major change in the plant community and low forage production. Early seral means that most of the palatable, native plants have been killed, forage production is very low, and adjustment of livestock grazing may not be a feasible means for attaining an upward trend (Range Inventory Standardization Committee 1983).

The Wyoming big sagebrush community is used here as an example of ecological status (fig. 2). Table 1 lists some common plant species and their crown cover that might be expected within the four condition classes. In PNC, bluebunch wheatgrass clearly dominates the herbaceous layer under a 12-percent crown canopy of sagebrush. Forage production averages about 600 lb/acre (672 kg/ha) per year, of which wheatgrass contributes about two-thirds. Wheatgrass plants are the most palatable, and they decrease in number and vigor when they are closely grazed. Forage production also decreases. At the same time, less palatable species, such as Sandberg's bluegrass and needle and thread grass, increase, which changes the condition to late seral. With continued close grazing, even these less palatable plants are overused and begin decreasing as did wheatgrass. In the midseral condition, only vestiges of wheatgrass are present and forage production falls to one-third of the potential.

Figure 2.—Wyoming big sagebrush/wheatgrass community used as an example for ecological status.

Table 1—Ecological status classes in the Wyoming big sagebrush plant community[1]

Plant species	Condition classes, by crown cover			
	Potential natural community	Late seral	Midseral	Early seral
	Percent			
Wyoming big sagebrush	12	14	16	18
Bluebunch wheatgrass	10	7	4	—
Needle and thread grass	2	3	2	—
Sandberg's bluegrass	5	7	5	2
Forbs	5	6	7	5
Cheatgrass brome	1	3	7	10
	lb/acre (kg/ha)			
Forage production	600 (670)	400 (450)	200 (225)	100 (110)

[1]Based on Range Inventory Standardization Committee (1983) criteria: Potential natural community is 75 percent or more of the ecological site potential; late seral, 50-75 percent; midseral, 25-50 percent; and early seral, 0-25 percent.

Nearly all native, palatable species may eventually be killed, which would leave the introduced annual cheatgrass brome as the primary forage producer in the early seral condition. In this plant community, the crown cover of sagebrush increases somewhat when the range trend is downward.

Sometimes the range manager's objective is to graze livestock in a manner that maintains the PNC or fosters an upward range trend toward it. At other times, existing vegetation may be manipulated to increase production of livestock forage. If sagebrush is killed in the Wyoming big sagebrush type, competition with grasses is reduced and forage production increases from an average 600 lb/acre (672 kg/ha) to about 1,100 lb/acre (1232 kg/ha). Under natural conditions, fire commonly reduces sagebrush.

In midseral and early seral conditions, cheatgrass brome is found in increasing abundance. Because it is an annual, yearly production is influenced mainly by growing conditions in the spring (Klemmedson and Smith 1964). High fluctuations in production are not conducive to sound ranch management. Therefore, crested or fairway crested wheatgrass, both perennial grasses, are commonly seeded after sagebrush is controlled. Like the native wheatgrass, they can produce 900 to 1,100 lb/acre (894 to 1232 kg/ha) of forage. Forage for wildlife, such as pronghorns, mule deer, and sage grouse, can be enhanced if adapted forbs are included.

Characteristics of Livestock Management

Livestock management deals with grazing the right kind of animals at the right place at the right time in the proper number. What is "right" depends on land management objectives (fig. 3).

Domestic livestock management directly affects wildlife habitat in two ways—the alteration of vegetation to enhance livestock forage and the consumption of vegetation by livestock. Indirect effects on wildlife are caused by fences and water developments used to distribute livestock. These direct and indirect effects may cause competition for forage, create social interaction between livestock and wildlife, alter wildlife home ranges or territory through water development, introduce hazards or change wildlife use by fencing, and increase harassment from humans by roadbuilding. For a better understanding of livestock management, the following topics are discussed: behavior of livestock, livestock grazing systems, forage utilization, livestock distribution, and vegetation treatment to enhance livestock forage.

Figure 3.—One system of ranching in the Great Basin is a "cow-calf operation" where calves are sold in the fall after they are weaned. Distribution of cows with calves is influenced by water and by the thermal cover that may be provided by juniper trees.

LIVESTOCK BEHAVIOR

Cattle ranching in the Great Basin usually concentrates on one of two age classes of livestock: cows with calves or yearlings. A herd composed of cow-calf combinations is often characterized by poor livestock distribution over the range because the cow is unwilling to travel long distances with a calf at her side (fig. 3). This is particularly important when water is poorly distributed because the cow needs abundant water for milk production. Cows are often retained in the base herd 6 to 10 years. Such cows develop traditional patterns of grazing that may not provide good distribution. In general, cows scatter over the range best in the spring and fall when the weather is cooler and less energy is dissipated in movement.

Yearlings distribute themselves better across the range than cows with calves do. Because they are relatively young, they have little knowledge of the range and scatter to explore new and different environments. The youth and vigor of yearling induces them to travel farther from water and on steeper and rockier slopes than cows and calves commonly do.

Cattle are primarily grass eaters, but they do consume forbs and shrubs, such as bitterbrush and mountain-mahogany. Because they have only lower incisors and comparatively thick lips, they ordinarily graze no closer than 1 to 2 in (2.5 to 5 cm) from the ground.

Domestic sheep, when accompanied by a herder, can be distributed in almost any way the land manager desires. They can be managed in open herds with a "once over" grazing system resulting in almost imperceptible use. Or they can be tightly herded with two or three passes over the same area resulting in very close use. The method of herding and degree of utilization is at the discretion of the land manager. In general, sheep prefer forbs and, because of their small mouths and thin lips, easily crop vegetation to within 0.5 in (1.3 cm) of the ground. They can negotiate steeper and rockier topography than cattle can.

Horses are the most selective feeders among livestock, whether wild or domesticated. Grass is eaten almost exclusively, but most unevenly. Horses repeatedly graze the same grass plants and leave adjacent ones untouched. With incisors in both upper and lower jaws, they easily crop vegetation to within 0.5 in (1.3 cm) of the ground. This produces extremely uneven grazing of grasses and kills certain grass plants and leaves others of the same species untouched. Horses distribute themselves well across available rangelands because they often move long distances from water to feeding areas.

GRAZING SYSTEMS (CATTLE AND SHEEP)

Livestock grazing systems are characterized by season, frequency, and intensity of use. Grazing intensity, often measured by how close to the ground (stubble height) vegetation is used, varies greatly and is hard for managers to regulate. The objective is to confine the right animals in the right place at the right time in the proper numbers to attain the desired intensity of grazing that meets land management objectives. Pastures are usually fenced and provided with water to accomplish grazing management objectives.

In the Great Basin of eastern Oregon, season of use is generally keyed to important forage plants, such as bluebunch wheatgrass, and is related to the plant's phenological development. Early spring use starts as grasses begin growth and terminates just before the boot stage of development. Early use lasts until seed maturity. Midseason starts when grasses are in the boot stage and continues to seed maturity. Late use occurs after seed maturity but when the plants still have some green color. Fall use occurs after late use, generally during September and October after grasses have lost color and are essentially dormant. Season-long use generally runs from plant green-up (March or April) to dormancy (September to October), during which time livestock remain in the same pasture for the entire season. Winter use occurs after fall use, from November to initiation of spring growth.

These seasons of use affect plants physiologically in different ways. For example, early spring use, when livestock are removed from the pasture at about the boot stage of grass development, does little physiological damage to the grazed plants if there is enough soil moisture to allow plants to complete development through seed ripening.

On the other hand, midseason use, when grasses are grazed between the boot stage and seed ripe, has the potential of most serious physiological damage, particularly if the grass is bitten off within 1 to 2 in (2.5 to 5 cm) of the ground. In such cases, plants cannot maintain sufficient green leaves to produce adequate energy and nutrient reserves. Most of the energy and nutrients stored from the previous season are used to grow leaves and seedstalks, which cannot replace the expended energy when they are continuously grazed. Also, some nutrients must be stored in the root crowns for initiation of growth the next growing season. Close grazing not only reduces leaf surface but also prevents flowering, the physiological trigger that transfers available nutrients to root

storage. Bluebunch wheatgrass can be killed in 3 to 5 years if it is reduced to a 1- to 2-in (2.5- to 5-cm) stubble during this phenological stage. Winter use, even when plants are grazed to a 1- to 2-in stubble, seldom damages the plants physiologically. This stubble provides little protection for crown of the grass, however. Severe low temperatures with lack of snow cover can damage the plants. Grazing systems, therefore, have two objectives: to maintain or enhance plant vigor that is governed by season and closeness of use and to produce an optimum amount of livestock gain that is accomplished by good distribution of livestock and careful regulation of forage utilization.

Grazing systems vary in complexity, from season-long grazing in a single pasture to high-intensity, short duration, repeated grazing in five or more pastures (such as Savory's holistic management concept) (Walter 1984). The following discussion applies to cattle and unherded sheep, but any of the grazing systems can be applied to herded sheep on unfenced rangeland. The number of pastures, and therefore the amount of fence and the number of water developments, depends on the grazing system used.

Season-long grazing requires one pasture and enough water, generally within less than 3 mi (5.8 km), to maintain the livestock for a grazing season. Livestock are introduced in the spring and removed in the fall. Distribution is attained by placement of salt and water, or herding. In areas where western juniper occurs, thermal cover (shade) can be almost as important as water for influencing livestock distribution.

If livestock are not grazed season-long, they are most commonly moved (rotated) between two or more pastures. Rotation grazing can be divided into three kinds: deferred, rest, and high-intensity, frequent rotation.

Deferred rotation means that an entire range area is grazed every year, but some parts are deferred from grazing during some portion of the growth period of key forage species. In its simplest form, this is a two-unit system where pasture A is grazed early, during active growth in the spring and early summer and pasture B is deferred from use. Sometime about midsummer, livestock are transferred to pasture B for late season use after forage plants have begun to mature. The next year, livestock graze early in pasture B and at midsummer are moved to pasture A.

Rest rotation requires that a certain proportion of the range area be rested completely from grazing for a whole year on a scheduled basis (fig. 4). In its simplest form, three pastures are required: pasture A is grazed during the first half of the season, livestock are moved to pasture B for the second half of the season, and pasture C is rested the entire grazing season. The next year, pasture B is grazed in the spring of the year, pasture C is grazed in the fall of the year, and pasture A is completely rested. The third year pasture C is grazed in the spring of the year, pasture A in the fall of the year, and pasture B is rested.

A third system involves high-intensity, short duration, repeated grazing developed by Savory (holistic management concept) (Walter 1984). Attention must focus on closeness of use, soil surface disturbance, and management objectives. "High intensity" does not always mean close use. Instead it means high *management* intensity in which livestock are moved when grazing on key vegetation and impacts on the soil surface reach the level specified for the pasture. In its simplest form: pasture A is grazed in the spring until use standards are met. Then livestock are moved in sequence to pastures B, C, D, and E. The time to move livestock is determined by the use level on key vegetation, degree of soil disturbance, and management objectives. Length of time in each pasture is governed by forage production and soil surface conditions. After pasture A has regrown enough to provide sufficient forage, livestock may be returned to it and may be subsequently rotated through the several pastures during the grazing season. Under this concept, most of the range area is grazed every year, often more than once. Intensity of use is adjusted according to physiological requirements of the plants and land management objectives.

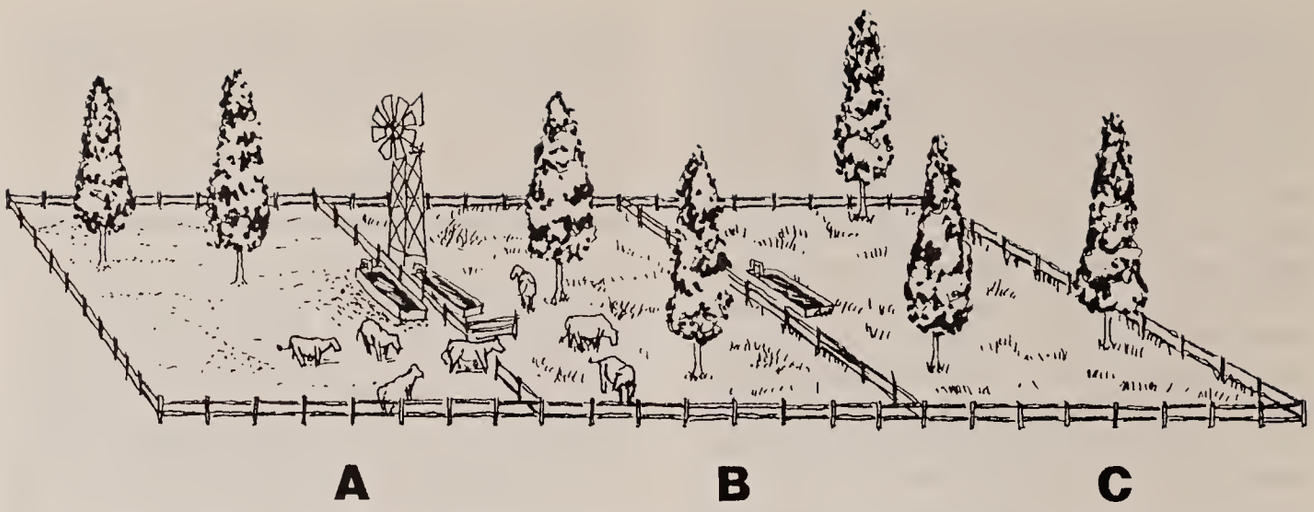

Figure 4.—One system for grazing livestock is a three-pasture, rest-rotation program. Livestock are concentrated in one pasture (A) during the first half of the grazing season, then moved to a second pasture (B). The third pasture (C) is rested for the entire season. The next year, the sequence of pastures is rotated so that a new area is rested the entire year.

1st year: Pasture A is grazed from June 1 to August 15; pasture B, from August 15 to October 30; pasture C is rested the entire year.
2d year: B, grazed June 1 to August 15; C, grazed August 15 to October 30; A, rested entire year.
3d year: C, grazed June 1 to August 15; A, grazed August 15 to October 30; B, rested entire year.
4th year: Repeat cycle, starting with A.

CLOSENESS OF FORAGE USE

Deferred rotation, rest rotation, and high-intensity, short duration grazing systems have one thing in common—close use of vegetation in pastures being grazed. All systems concentrate livestock in a relatively small tract where preferred grazing areas are quickly cropped to a stubble of 1 to 2 in (2.5 to 5 cm). The animals must then graze farther from water in less preferred areas. Vegetation near water is expected to be closely grazed. One objective of these systems is forced distribution of livestock so more of the total area can be grazed. Another objective is deferred use of plants on some portion of the area to restore their vigor.

This concentration of livestock and their close use of vegetation have impacts on wildlife; these impacts will be discussed later for each of the species featured in previous chapters. Grazing by livestock can be advantageous or disadvantageous to wildlife depending on species and circumstances. For example, a 1- to 2-in (2.5- to 5-cm) stubble is roughly equivalent to bare ground for wildlife that nest and feed on the ground. On the other hand, seasonal grazing by livestock removes old grass called "rough" and exposes regrowth of lush green grasses often heavily used by mule deer. A 6-in (15-cm) stubble may be as adequate as ungrazed bunchgrass for ground-dwelling wildlife.

Close use of vegetation by livestock does more than influence wildlife and wildlife habitat. It can affect plant species composition and density of the herbaceous layer. Repeated, close use to 1- to 2-in (2.5- to 5-cm) stubble during the growing season results in a decrease of bunchgrasses. This downward trend results in a midseral or an early seral condition characterized by dominance of the annual cheatgrass brome. On poor soils, the result may be essentially bare ground. But the midseral or even the early seral condition is not detrimental to all wildlife. For example, figure 5 (Maser et al. 1984) suggests that a greater number of

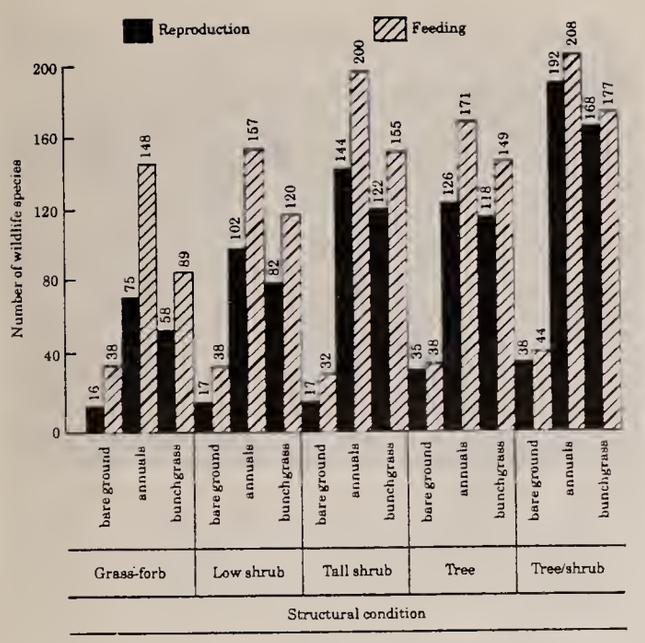

Figure 5.—Number of wildlife species oriented to desert-steppe structural conditions and the potential effect of intensive management (reproduced from Maser et al. 1984).

Figure 6.—Many water developments in the Great Basin are not natural. Well-placed water is the best means for obtaining good livestock distribution; however, these manmade water developments are of little benefit for wildlife if water is not maintained while wildlife are in the area. In this example, an electric pump would be needed to supply water. (Photograph courtesy of Chris Maser.)

wildlife species both reproduce and feed when annuals are dominant in the grass-forb, low shrub, tall shrub, tree, and tree/shrub structural conditions.

FENCES AND WATER

Livestock distribution is achieved primarily by means of fencing, water development, salt location, and maintenance of thermal cover where juniper or tall shrubs occur. Cattle will scatter over ranges with gentle topography when water is no farther than 2 mi (3.2 km) apart. In the Great Basin, natural water sources are seldom found this close together; therefore, additional sources of water are often developed. If wildlife enhancement is a management objective, these water sources should remain available throughout the season. This may be expensive if water is hauled or supplied by electric pump (fig. 6).

Fencing is the primary means by which livestock are contained within a specified area. Fences have significant impacts on wildlife movement, particularly pronghorns and bighorn sheep. A smooth wire at least 16 in (41 cm) above the ground and a top wire no higher than 36 in (92 cm) have the least impact on movement of pronghorns; for bighorn sheep, a smooth wire 20 in (51 cm) above the ground and a top wire no higher than 39 in (100 cm) have the least impact. A general recommendation is a smooth bottom wire 20 in (51 cm) above the ground, a top barbed wire no higher than 36 in (92 cm), and a third barbed wire between the other two wires. If steel fenceposts are used, their tops should be painted white to enhance visibility. Making the fence obvious is important in preventing collisions by wild ungulates and birds, such as sage grouse.

In many areas, soils are too stony and shallow to allow steel fenceposts to be easily driven into the ground. Fences in such situations are commonly constructed from rockjacks or rockcairns (fig. 7). Such fences can provide habitat attributes for some wildlife species. For example, rockjacks can provide cover and dens for small animals, particularly with a 4- to 6-in (10- to 15-cm) gap between the ground and the bottom of the rockjack. Rocks greater than 12 in (31 cm) in diameter provide large enough crevasses for several species of wildlife (Maser et al. 1979).

Figure 7.—Fences are the second most important means for controlling livestock. On soils too shallow to support steel fenceposts, rockjacks are used for stability.

VEGETATION TREATMENT

When land is managed primarily for livestock production, the principal reason for manipulating vegetation is to increase forage for livestock. In the Great Basin, this often entails killing or removing shrubs, trees, or both to reduce competition with grass. Where sites are in the late seral or the PNC condition, control of woody species allows native grasses and forbs more nutrients, moisture, and sunlight. With these nutrients they will be more productive and will provide additional forage for livestock.

When such sites are in the midseral or the early seral condition, not enough bunchgrasses remain to provide adequate forage, so the area is often seeded to crested or fairway crested wheatgrass. On a Wyoming big sagebrush site dominated by sagebrush, for example, the midseral condition may produce only 200 lb/acre (224 kg/ha) of forage in the form of cheatgrass brome and Sandberg's bluegrass. With shrub control and successful seeding of crested wheatgrass, forage production can be increased to 900 to 1,100 lb/acre (1010 to 1235 kg/ha).

The method of vegetation manipulation influences structure and dominance of plants after treatment. For example, burning, whether natural or prescribed, not only kills woody plants but also eliminates their structure from the stand. It may enhance habitat for a number of wildlife species. Mule deer and pronghorns often select recently burned areas for feeding (Leckenby et al. 1982, Kindschy et al. 1982). On the other hand, chemical control of shrubs has two significantly different after effects. First, the dead shrubs remain, and they often retain the shrub structure that does not enhance the areas for such species as the horned lark and bighorn sheep. Second, chemicals that kill the shrubs, such as 2,4-D, also kill forbs. Forbs are part of the staple diet for sage grouse (Call and Maser 1985) and pronghorns (Kindschy et al. 1982). Mechanical treatment of woody vegetation has intermediate effects on wildlife. For example, chaining changes the structure from tree/shrub or shrub to grassland but leaves residue on the ground that creates microhabitat for small animals (Maser et al. 1979).

The consideration of edges by managers when they are planning treatments to vegetation can have important ramifications for wildlife (Thomas et al. 1979). In general, some treatment of large, homogeneous tracts is advantageous to wildlife, such as mule deer (Leckenby et al. 1982) and pronghorns (Kindschy et al. 1982) (fig. 8). On the other hand, heterogeneous vegetative complexes composed of natural grassland, low shrub, tall shrub, and tree/shrub communities may already be close to optimum in terms of habitat diversity and wildlife. Manipulation of vegetation could cause simplification of vegetative structure and thus reduce diversity (fig. 9).

Figure 8.—In some plant communities, such as Wyoming big sagebrush, herbage production for livestock can be greatly increased by seeding crested wheatgrass after sagebrush is controlled. Interspersion of revegetated tracts in a homogeneous tract of sagebrush can enhance wildlife habitat by creating edges and introducing different stand structure and thus increasing wildlife diversity.

Figure 9.—An area with good natural diversity of plant communities: quaking aspen, meadow, Wyoming big sagebrush, and low sagebrush ridges. Revegetation on the hills adjacent to the aspen and meadow might increase herbage production but might not enhance vegetation diversity to the advantage of wildlife.

It is not possible to deal with all wildlife species of the Great Basin here; however, the wildlife species featured in other chapters in this series are discussed in relation to livestock management. This discussion shows how wildlife can be considered in relation to management of livestock grazing.

Featured Species and Grazing

Habitat characteristics have been summarized from the chapters in this series that deal with the following species: native trout (Bowers et al. 1979), sage grouse (Call and Maser 1985), pronghorns (Kindschy et al. 1982), mule deer (Leckenby et al. 1982), and bighorn sheep (Van Dyke et al. 1983).

NATIVE TROUT

Livestock impacts on native trout occur primarily in riparian areas. Optimum habitat for native trout has the following characteristics: water temperatures less than 70 °F (21 °C), stable streambanks, minimum sedimentation, and adequate instream or streambank cover. Streamside vegetation is particularly important as it provides shade that reduces water temperature, produces leaves that fall into the stream for primary and secondary reducers, both of which are food for trout, and provides habitat for other insects that can be eaten by trout. In addition, abundant streambank vegetation reduces erosion and thus minimizes siltation over spawning gravel. Instream cover, such as boulders, is also important, but overhanging vegetation along the streambanks more than 2 ft (0.6 m) above the water can effectively replace instream cover (fig. 10).

Figure 10.—Stream edge in the riparian area healing from past heavy use by livestock. In many cases, light to moderate use, such as leaving a 4-in (10-cm) stubble, is compatible with enhancement of the riparian vegetation. (Photograph courtesy of Oregon Department of Fish and Wildlife.)

Livestock use in riparian areas can affect trout habitat in several ways. As cattle travel to and from water, they can break overhanging streambanks that partially shade the stream. Close cropping of forbs and grasses by cattle reduces vegetation along the streambank and often prevents or eliminates woody vegetation that can provide shade to the stream system. Some studies in the Great Basin area and elsewhere have demonstrated a twofold to threefold increase in trout biomass with livestock use controlled enough to permit banks to build an overhang and woody vegetation to colonize and grow along the streambank (Bowers et al. 1979).

Intensity of livestock use is apparently the key to maintaining or enhancing native trout habitat. When vegetation is grazed to a 1- to 2-in (2.5- to 5-cm) stubble for extended periods, establishment and growth of woody vegetation are inhibited and overhanging banks do not develop. Such stubble heights are common in deferred and rest rotation grazing systems because livestock are grazed in sufficient numbers to force use away from the riparian areas onto less palatable dryland forage. Light to moderate livestock use, leaving a 4- to 6-in (10- to 15-cm) stubble, appears compatible with protection of the riparian area and native trout habitat.

SAGE GROUSE

Sage grouse depend almost entirely on areas dominated by sagebrush for habitat. They prefer level to low rolling topography with slopes generally less than 30 percent. Some sage grouse migrate from lower to higher elevations after forbs develop though they remain mainly in sagebrush-dominated areas. Their movements are strongly influenced by the availability of free water; they therefore have strong affinities for riparian areas. Breeding occurs in the spring on open areas called leks (fig. 11). These areas are characterized by bare or relatively bare ground and range in size from 10 to 100 acres (4 to 40 ha). Leks are usually adjacent to nesting and brood-rearing habitat.

Figure 11.—Sage grouse strutting on a lek. The lek characteristically has little or no sagebrush and is in early seral to midseral community. It is usually adjacent to nesting areas where sagebrush is essential. (Photograph courtesy of Oregon Department of Fish and Wildlife.)

Optimum nesting habitat is characterized by 20 to 40 percent crown cover of sagebrush ranging from 7 to 30 in (18 to 77 cm) tall. A dense understory of herbaceous vegetation is important; a late seral condition or PNC is near optimum habitat. Close early grazing by livestock is a disadvantage to sage grouse because it reduces cover and availability of forbs important as food during the nesting and brood-rearing seasons.

Brood rearing occurs in sagebrush but requires only 8 to 14 percent crown cover of shrubs shorter than those preferred for nesting habitat. Low sagebrush types are commonly used during brood rearing; an interspersion of openings is considered advantageous. Sage grouse move away from snow-covered areas to lower elevations to spend the winter, during which time they feed almost exclusively on sagebrush leaves. Sage grouse seem to prefer low sagebrush, but when this species is covered with snow they will feed on taller sagebrush species. Sagebrush canopy cover exceeding 15 percent characterizes the best sage grouse winter ranges.

Local knowledge of sage grouse behavior is essential in developing land management plans. Grouse have strong tendencies to use the same lek year after year and the same nesting and brood-rearing areas. Almost any vegeta-

tion treatment within 2 mi (3.2 km) of a lek can have detrimental effects on sage grouse welfare. Therefore, the land manager should determine the location of all leks that are to be maintained as part of the management plan.

This does not, however, preclude some manipulation of vegetation within occupied sage grouse ranges. For example, sage grouse will use areas with sagebrush below the preferred 20 to 40 percent crown cover. Some treatment of sagebrush, such as reducing cover from 40 to 20 percent may not seriously degrade habitat. Indeed, it might provide for more herbaceous food plants. Sagebrush control in areas with less than 20 percent shrub cover is generally considered detrimental. Treatment of sagebrush might be confined to a few of the most productive sites for livestock forage and adequate stands be left between treated areas.

New leks might be developed by removing sagebrush, provided they are adjacent to good nesting and brood-rearing habitat. Sagebrush can be removed from 10- to 100-acre (4- to 40-ha) tracts on sites in midseral and early seral conditions that would provide minimum ground vegetation. These leks can be made additionally attractive if free water is provided nearby.

Intensity of livestock use can affect the success of sage grouse nesting and brood rearing. Nesting requires both sagebrush cover and herbaceous plants. Therefore, grazing to a 1- to 2-in (2.5- to 5-cm) stubble during these activities is detrimental. Such close grazing will result in significant use of spring forbs by livestock; these forbs are a key element in the grouse diet. If management of sage grouse is an objective, the land manager might consider grazing livestock to leave a 4- to 6-in (10- to 15-cm) stubble. This will provide some cover and also provide sufficient forbs for spring use by nesting and brood-rearing grouse.

When vegetation in sage grouse habitat is treated, special concern should be directed toward use of chemicals, such as 2,4-D. Chemicals kill sagebrush and thus eliminate sagebrush forage for the grouse and reduce hiding cover. In addition and perhaps equally important, these same chemicals may kill the forbs that are essential in the spring and early summer diet of sage grouse.

PRONGHORNS

Pronghorns prefer level to gently rolling topography as habitat. Large bodies of water, escarpments, mountains, canyons, and tall shrub or forest areas are barriers to their movements. They require water with a pH less than 9.25 and less than 4,500 p/m of solids. Optimum habitat is about 50 percent crown cover of plants, a significant portion in herbaceous vegetation (fig. 12). They avoid sagebrush areas where the shrubs exceed 20 in (51 cm) in height. Because they are primarily forb eaters, the midseral condition seems optimum. Pronghorns effectively use crested wheatgrass seedings if forbs have been seeded.

Figure 12.—Pronghorns prefer areas with little or no shrub cover and a high proportion of forbs in the herbaceous vegetation. Optimum ecological status is midseral to late seral. Grass seeding can enhance pronghorn habitat if forbs are seeded in the mixture. (Photograph courtesy of Oregon Department of Fish and Wildlife.)

A high diversity in plant species composition seems attractive to pronghorns. Extensive tracts of homogeneous shrubland, such as 3,000+ acres (1215+ ha) of Wyoming big sagebrush, are not optimum pronghorn habitat. Habitat can be enhanced by manipulation of vegetation. For example, controlling sagebrush or western juniper on areas less than 1,000 acres (405 ha) and generally no more than one-third the home range of pronghorns can be beneficial. In treatment of vegetation, the manager should remember that chemicals may kill desired forbs. Fire can be an effective means of

manipulating vegetation to benefit pronghorns. Fire can be prescribed to result in less than 100 percent kill of sagebrush, and it stimulates forbs and enhances palatability of forage. Pronghorns have been observed seeking out burned areas for feeding (Kindschy et al. 1982).

Fencing can be detrimental to pronghorns. Because pronghorns do not commonly jump, the lower wire of a fence should be high enough to permit them to crawl under it. A smooth wire 16 in (41 cm) above the ground is acceptable. The fence should have no stays, and white-topped fenceposts will make the fence more visible to pronghorns. Water developments to enhance livestock distribution can be of significant advantage to pronghorns if they are available when pronghorns occupy the area.

Moderate cattle grazing seems complementary to pronghorns because cows, preferring grasses, leave the forbs for the pronghorns (Kindschy et al. 1982). Cattle grazing must be controlled if close use of forbs is to be avoided. Some direct competition occurs between domestic sheep and pronghorns because both species feed primarily on forbs. If pronghorn welfare is a primary concern, sheep should not be grazed. If sheep are to be grazed, the closeness of use should be limited to assure that appropriate amounts of forbs remain for the pronghorns. Although close livestock use seems to be detrimental (that is, a 1- to 2-in (2.5- to 5-cm) stubble), moderate livestock use that leaves a 4- to 6-in (10- to 15-cm) stubble, may be complementary to both livestock and pronghorn welfare. Sufficient winter forage should remain for the pronghorns after livestock grazing. Some moderate use may make grasses the pronghorns eat more palatable by removing old rough grass.

MULE DEER

Mule deer use traditional home ranges whether they are migratory or are year-round residents. For this reason, management relating to mule deer should consider subpopulation areas of about 11,500 acres (4656 ha). Two kinds of social groups are common: does with fawns, and males. Five habitat attributes are important: (1) thermal cover, (2) hiding cover, (3) forage areas (4) fawning habitat, and (5) fawn-rearing habitat. Thermal cover is provided by woody vegetation over 5 ft (1.5 m) tall, with crown cover exceeding 50 percent in tracts at least 2 to 5 acres (0.8 to 2.0 ha). Hiding cover is defined as vegetation greater than 24 in (61 cm) tall that can hide 90 percent of a bedded deer at 150 ft (46 m) or less (fig. 13). Tracts should be at least 600 to 1,200 ft (183 to 366 m) in diameter, which equals 6 to 25 acres (2.5 to 10 ha). Forage areas are defined as tracts where the structure of the vegetation does not meet thermal or hiding cover criteria but does produce forage. Because mule deer have affinities for edges, forage areas should be less than 1,200 ft (366 m) across. Deer and cattle compete for forage; however, moderate cattle use, which removes rough grass, can enhance these areas for deer.

Figure 13.—Mule deer in hiding cover—shrubs tall and dense enough to hide 90 percent of a bedded deer at 150 ft (45.7 m). They have affinity for edges in landscapes with a variety of plant communities and structural conditions. (Photograph courtesy of Oregon Department of Fish and Wildlife.)

Fawning habitat is characterized by shrubs greater than 28 in (72 cm) tall and with more than 40 percent crown cover, is within 160 ft (50 m) of tree cover, has succulent forage, is 5 to 25 acres (2 to 10 ha) in size, and is close to water—within 2,000 ft (610 m). This description suggests that riparian areas are optimum habitat. Fawn-rearing habitat is similar to fawning habitat; however, it is desirable to have larger tracts of land with more diverse

plant communities. The optimum diversity of mule deer habitat is 55 percent in forage area, 20 percent in hiding cover, 10 percent in thermal cover, 10 percent in fawn-rearing habitat, and 5 percent in fawning habitat. Thermal cover is thought to be a critical component. If adjustments in cover are desired, thermal cover should be increased at the expense of other cover.

In treatment of vegetation to enhance mule deer habitat, current vegetative conditions must be considered. Variable topography and a variety of plant communities creating a mosaic of edges, forage areas, and cover enhance mule deer habitat. Extensive tracts of homogeneous vegetation, such as Wyoming big sagebrush, can be significantly improved for mule deer habitat by vegetation treatment; as much as 55 percent of an area can be treated to remove or reduce sagebrush to create forage areas. The key is to select the sites best suited for forage production. Then other characteristics of habitat should be considered such as maintaining widths less than 1,200 ft (366 m) across treated areas, maximizing edges, and providing for sufficient thermal cover. Water should be kept available to mule deer when they are on the area.

Intensity of livestock use can be adjusted to enhance production of forage for mule deer. Moderate use by cattle will remove rough grass and afford deer the opportunity to forage on regrowth or spring growth of grasses protruding above the rough. Livestock grazing should be regulated to insure only light use of forbs and browse. Close livestock use, which causes a downward range trend, can be detrimental to mule deer range.

BIGHORN SHEEP

Bighorn sheep are very traditional in their occupation of specific ranges, are slow to pioneer new habitats, and are extremely sensitive to disturbance. They prefer remote, rugged, steep terrain with open plant communities that are low in structure. Keen vision is their primary mechanism for detecting danger. They shun forest stands and areas with shrubs more than 2 ft (0.6 m) tall. Key habitat components are open forage areas, escape terrain, water, thermal protection, and traditional lambing and rutting areas (fig. 14).

Figure 14.—Bighorn sheep in a near ideal setting of forage area, escape cover, and terrain that significantly limits easy travel by other large animals. They are socially sensitive to domestic livestock and often leave areas grazed by cattle. (Photograph courtesy of Walter A. Van Dyke.)

Presence of escape terrain regulates use of other areas. Such escape terrain is composed of cliffs, rimrock or outcroppings, bluffs, and topographic features most other animals have difficulty negotiating. Thermal protection is often provided by topography and elevation. Bighorn sheep also obtain thermal regulation by bedding in windy or wind-protected areas depending on the circumstances. Forage areas are relatively open with low vegetation, no farther than 0.5 mi (0.8 km) from escape terrain and within 1 mi (1.6 km) of water. Shrubs are mostly less than 2 ft (0.6 m) tall with less than 25 percent crown cover. Lambing areas are traditional; they occur in rugged, precipitous, remote terrain with adequate forage and water. In general, they exceed 5 acres (2 ha) in size. Intrusion by people and competing animals is detrimental. Fresh water with a reasonably low pH is important. Water in summer is of particular value.

Because bighorn sheep are primarily grass eaters, they compete directly with cattle for forage. They will sometimes leave areas grazed by livestock because of their sensitivity to this competition. For enhanced conditions for bighorn sheep, livestock should not be grazed with bighorn sheep; if they are grazed, use should be adjusted to leave sufficient forage for sheep.

Fences are important in controlling livestock, but they may hinder movement of bighorn sheep. Recommended fence construction is a smooth wire 20 in (51 cm) off the ground with a top barbed wire no higher than 39 in (100 cm) above the ground.

Transmittal of diseases between bighorn sheep, cattle, and particularly domestic sheep, sometimes is a problem. Waterholes and salt grounds should not be used by domestic livestock when bighorn sheep are in the area.

Human intrusion into bighorn sheep territory is most detrimental. The sheep have abandoned good habitat because of their low tolerance for humans. Therefore, management should provide for control of people.

These constraints on bighorn sheep habitat seem to imply that no management activities should be carried out on ranges occupied by bighorn sheep. This is not necessarily true. For example, forage areas adjacent to escape terrain and available water may be improved by shrub control. Grasses and forbs can be seeded on ranges depleted of perennial grasses. Water sources can be developed to enhance bighorn sheep range. In general, these improvements should be fenced to exclude livestock if bighorn sheep habitat is to be enhanced to its fullest. If cattle are to graze in bighorn sheep range, they must be carefully controlled as to season and intensity of use to avoid social interaction and forage competition with bighorn sheep.

Management for Species Richness

So far, livestock management has been discussed as it affects several featured species. An alternative or additional wildlife objective is species richness management in which habitat is manipulated to insure that all native species remain in viable numbers in the area under management (Maser and Thomas 1983).

Diversity was thoroughly discussed in the chapter of this series on edges (Thomas et al. 1979), which dealt with interspersion, inherent and induced edges, species richness, size of habitat blocks, and contrast in structure of plant communities. Tract management for species richness is based on habitat blocks averaging about 200 acres (81 ha) in size.

The land manager commonly must strike a balance between meeting species richness goals and optimizing habitat for one or several featured species (fig. 15). For example, optimum mule deer habitat has 55 percent of the land in forage areas that is in the grass-forb structural condition (Leckenby et al. 1982). For optimum habitat for pronghorns only 33 percent of the area need be in a grass-forb structural condition (Kindschy et al. 1982), whereas for sage grouse habitat only 2 percent of the land area need be in a grass-forb structural condition (Call and Maser 1985). Clearly, the land manager cannot manipulate vegetation so as to maximize habitat conditions for mule deer, pronghorns, and sage grouse on the same tract of land. Similarly, the manager cannot maximize species richness and the habitat conditions for a featured species on the same tract at the same time.

The land manager must deal with the interaction of livestock and wildlife. Livestock, with their attendant use of forage, compete directly with some species of wildlife for forage; they create adverse effects for some wildlife through social interactions or produce a complementary situation for some wildlife species, depending on the intensity of livestock grazing and the season of use. Properly done, livestock grazing can enhance mule deer habitat, whereas livestock presence can be an intolerable intrusion on bighorn sheep ranges.

Figure 15.—Diversity in plant communities and stand structure provides for a variety of wildlife habitats and therefore enhances wildlife species richness. Species richness may be enhanced by vegetation treatment in areas with large expanses of homogeneous vegetation. In this case, the best grass growing area has been seeded to crested wheatgrass to create habitat for horned larks, a forage area for pronghorns, and edges for mule deer. (Photograph courtesy of Chris Maser.)

Practices for the simultaneous management of livestock and wildlife in the Great Basin constitute a complex series of tradeoffs involving biology, economics, legal requirements, and social pressures. At least for the present, livestock grazing is the dominant use of the lands in question. The task for the manager, then, is to determine how best to manage livestock and manipulate vegetation in a cost-effective manner for enhanced livestock production, and at the same time provide a minimum detrimental impact on wildlife or, if possible, enhance wildlife habitat. Even if livestock grazing were excluded from public lands in the Great Basin, the resulting circumstances would not provide optimum habitat conditions for featured species or ideal conditions for species richness. For example, very large tracts of climax sagebrush is not optimum habitat for most wildlife species in the Great Basin of southeastern Oregon (Maser et al. 1984). The land manager has a myriad of opportunities and constraints to consider when formulating management objectives and alternatives. In general, no matter what the manager does or does not do, the habitat of some species of wildlife will be enhanced and that of others diminished. It is the clear intent of the law under which public land managers operate (see Maser and Thomas 1983) that these effects be considered and evaluated when management decisions are made. The chapters in this series provide the means to deal with wildlife in the managed rangelands of southeast Oregon.

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Appendix

COMMON AND SCIENTIFIC NAMES

Common name	Scientific name
PLANTS	
Bitterbrush	*Purshia tridentata*
Bluebunch wheatgrass	*Agropyron spicatum*
Cheatgrass brome	*Bromus tectorum*
Crested wheatgrass	*Agropyron desertorum*
Fairway crested wheatgrass	*Agropyron cristatum*
Low sagebrush	*Artemisia arbuscula arbuscula*
Mountain-mahogany	*Cercocarpus ledifolius*
Needle and thread grass	*Stipa comata*
Quaking aspen	*Populus termuloides*
Sagebrush	*Artemisia* spp.
Sandberg's bluegrass	*Poa sandbergii*
Western juniper	*Juniperus occidentalis*
Wheatgrass	*Agropyron* spp.
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*
ANIMALS	
Bighorn sheep	*Ovis canadensis*
Cow	*Bos taurus*
Domestic sheep	*Ovis aries*
Horned lark	*Eremophila alpestris*
Horse	*Equus cabalus*
Mule deer	*Odocoileus hemionus*
Native trout	*Salmo* spp.
Pronghorn	*Antilocarpra americana*
Sage grouse	*Centrocercus urophasianus*